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Preface

Agricultural Finance Review provides a forum for presentation of research and discussion of issues in agricultural finance. This regular annual publication contains articles contributed by scholars in the field and refereed by peers. Publication is annual except for special issues. A special issue of Volume 47 was published in March 1987.

Volume 43 was the first to be published at Cornell University. The previous forty-two volumes were published by the U.S. Department of Agriculture (USDA). AFR was begun in 1938 by Norman J. Wall and Fred L. Garlock whose professional careers shaped much of agricultural finance research for many years. Professional interest in agricultural finance continues to grow, involving larger numbers of people and a greater diversity in research topics, methods of analysis, and degree of sophistication. We are pleased to be a part of that continuing development. We invite your suggestions for improvement in AFR.

The effectiveness of this publication depends on its support by agricultural finance professionals. That support has continued to grow in terms of manuscripts received and reviews of manuscripts. Twenty-eight manuscripts were received for this volume, and fifty-six individuals provided reviews—some more than one. We express thanks to those whose names are listed below. Grateful appreciation is also expressed to the Economic Research Service, USDA, for partial financial support. In addition, page charges and Myers Estate funds support this publication.

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Manuscripts will be accepted at any time, but the deadline for manuscripts for the 1990 issue is February 5, 1990.

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Appreciation is expressed to Loren Tauer for his past service as associate editor.

Farm Operators and Federal Tax Incidence: An Analysis of Two Decades of Changing Federal Income and Employment Tax Laws

Clair J. Nixon and Larry W. VanTassell

Abstract

Income and self-employment tax incidence was determined for profitable married farm operators by varying income levels for the 1970–90 period. Between 1970 and 1990, self-employment tax increases more than offset reductions in income tax liabilities for low- and middle-income farm families. On the other hand, by 1990, high-income farm families will enjoy the same relative tax position that they had in 1970. The difference between effective tax rates for high- and low-income farm families will narrow from more than 11 percent in 1970 to less than 10 percent by 1990.

The past two decades have been associated with widely varying net farm incomes as measured by the U.S. Department of Agriculture (USDA) (Table 1). These changing income levels have been directly and indirectly impacted by vacillating federal farm programs and general economic conditions. Farm operators have likewise experienced large swings in farm taxable income during this period. The 1970s were generally known as an era of positive farm taxable income compared with the 1980s when farm income has been negative overall. While the federal government has pumped billions of dollars into the farm sector, it has also collected billions of dollars from farm operators in the form of individual income and self-employment taxes. The purpose of this study is to measure the federal tax incidence of profitable farm operators within alternative income classifications during the 1970–90 period.[1]

The last twenty years have seen significant change in federal income and employment tax policy. For example, during the period the top marginal tax rate declined from 70 to 28 percent and personal exemptions more than tripled in value. On the other hand, a new alternative minimum tax was implemented and numerous credits and deductions were eliminated. In addition, for

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[1]Much of the tax paid by lower-income farm operators or part-time operators is from nonfarm sources. The focus of this study is to isolate positive farm income households. Those farming operations that had farm losses during the 1980s and negative adjusted gross incomes (accounting for nearly two-thirds of the losses during the 1980s) are not included in this study (Internal Revenue Service).

Table 1. Net Farm Income and Consumer Price Index for the Years 1970–90

Year	Net Farm Income	Consumer Price Index[a]
1970	$14,366	116.3
1971	15,012	121.3
1972	19,457	125.3
1973	34,357	133.1
1974	27,266	147.7
1975	25,547	161.2
1976	20,176	170.5
1977	19,882	181.5
1978	25,197	195.4
1979	27,416	217.4
1980	16,134	246.8
1981	26,879	272.4
1982	23,525	289.1
1983	12,689	298.4
1984	32,022	311.1
1985	32,337	322.2
1986	37,490	335.1
1987	46,263	348.5
1988	N/A	368.4[b]
1989	N/A	377.1[b]
1990	N/A	392.2[b]

Source: *Economic Indicators of the Farm Sector, National Financial Summary, 1987*. Economic Research Service, U.S. Department of Agriculture, ECIFS 7-1.

[a]Base year 1967. Bureau of Labor Statistics. *CPI Detailed Report September 1988*. U.S. Department of Labor, November 1988.

[b]Estimate.

sole proprietors, a rapidly rising self-employment tax rate and wage base greatly enhanced their exposure to self-employment taxes. Studying the combination of self-employment and income tax changes provides a clearer picture of farm operator tax incidence over time.

Studies addressing the distribution of federal tax incidence have generally focused on income classifications and not industry groups (Browning; Congressional Budget Office). Still others have examined the trade-off between salary employment and self-employment (Long; Brittain). Within the farm sector, the literature is replete with studies on how farm operators are affected by changing income tax provisions (Hanson and Bertelsen; Chisholm; Nixon and Richardson 1982). Yet, little has been done to assess the impact of both federal income and self-employment tax policy on farm operator families.

Both income and self-employment tax provisions are examined, as they represent the largest share of farm operator payments to the federal government. In 1988, for example, it is estimated that individual income and employment taxes will represent more than 80 percent of total federal government receipts[2] (Department of the Treasury). Other federal taxes including corporate income taxes, estate and gift taxes, and excise taxes are excluded from this study due to the problems with allocating such taxes directly to individual taxpayer groups.

Background

The volume of tax legislation shifted into high gear during the past two decades, with increasing momentum during the 1980s. Major pieces of tax legislation affecting individuals enacted over the past two decades include the Tax Reform Act of 1969, the Tax Reduction and Simplification Act of 1977, the Social Security Amendments Act of 1977, the Revenue Act of 1978, the Economic Recovery Tax Act of 1981 (ERTA), the Social Security Amendments Act of 1983, and the Tax Reform Act of 1986 (TRA of 1986). This legislation altered individual tax rates, tax brackets, exemption values, itemized and standard deductions, and employment taxes. Other pieces of legislation with minor provisions affecting individual tax liabilities include the Tax Equity and Fiscal Responsibility Act of 1982, the Tax Reform Act of 1984 (TRA of 1984), and the Technical and Miscellaneous Revenue Act of 1988.

Employment Taxes

One of the most highly touted parts of the TRA of 1986 is the removal of millions of low-income families (many of which are farm operators) from the federal income tax rolls. Yet, those same millions are not fully relieved of federal tax payments. The self-employment tax structure does not provide a *poverty level* and is instead a highly regressive tax (Table 2). As such, what may be seen as a benefit from reduced

[2]The remaining estimated federal budget receipts excluding borrowing will be from corporate income taxes (11 percent), excise taxes (3 percent), and other (4 percent).

Table 2. Self-Employment Tax Contribution Rates, Maximum Taxable Earnings, and Maximum Employee Tax 1970–90

Year	Contribution Rate (Percent)	Maximum Taxable Earnings (Nominal Dollars)	Maximum Employee Employment Tax (Nominal Dollars)
1970	6.90	7,800	538
1971	7.50	7,800	585
1972	7.50	9,000	675
1973	8.00	10,800	864
1974	7.90	13,200	1,043
1975	7.90	14,100	1,114
1976	7.90	15,300	1,209
1977	7.90	16,500	1,304
1978	8.10	17,700	1,434
1979	8.10	22,900	1,855
1980	8.10	25,900	2,098
1981	9.30	29,700	2,762
1982	9.35	32,400	3,029
1983	9.35	35,700	3,338
1984	11.30	37,800	4,271
1985	11.80	39,600	4,673
1986	12.30	42,000	5,166
1987	12.30	43,800	5,387
1988	13.02	45,000	5,859
1989	13.02	48,000	6,249
1990	15.30	51,000*	7,803

Source: *Internal Revenue Code Section 1402*

*Estimate for 1990.

federal income taxes may be, in reality, an enhanced federal tax burden through increasing self-employment tax liabilities. In fact, the maximum exposure of self-employed farm operators to the self-employment tax has risen more than 1,500 percent, in nominal terms, from 1970 to 1990 (Table 2).

A critical assumption of this and similar studies is that the self-employment tax is not wholly an investment but rather a tax in the same manner as the income tax (Musgrave and Musgrave). In this study, there are two reasons for sharply discounting the investment value of self-employment tax payments. First, recent legislation (TRA of 1984) changed the taxable status of Social Security benefits. Prior to 1985, Social Security benefits were excluded from taxable income for all individuals. After 1984, however, up to one-half of the benefits are included in taxable income. Thus, the income of Social Security recipients cannot be strictly characterized as an income transfer.[3]

Second, the present value of expected benefits from Social Security may be nominal depending upon the number of years and level of contributions. For example, using the maximum 1988 benefit schedule and self-employed contribution, the present value of the contributions is more than ten times greater than the present value of the benefits for an individual age twenty-five, working until sixty-five, and having twenty years of maximum Social Security income. If inflationary adjustments are included, the present value gap widens further. Furthermore, in a recent study of expected Social Security retirement benefits and taxes for households of different marital status, income, and age, a great deal of variance was shown in the marginal linkage of benefits and taxes, with the present value of benefits for most households being only fifteen to thirty cents per dollar of taxes

[3]Currently, less than 10 percent of Social Security recipients are taxed on their benefits. However, Internal Revenue Code Section 86 (taxation of Social Security benefits) provides nonadjustable minimum income levels before benefits are subject to taxation. Over time, as benefits are tied to changes in the CPI, more and more retiring taxpayers will likely be subject to taxation on their Social Security payments (Chernick and Reschovsky).

paid (Boskin et al.). Only the extremely poor ($10,000 AGI or less) received an extra dollar's worth of benefits for an extra dollar of taxes paid. For many, their Social Security contributions are correctly viewed as taxes with the marginal linkage being zero for most workers in the first decade or so of contributions.

Sole Proprietor Tax Incidence Model

The following model is used to determine the effective federal tax rate for sole proprietors, which includes most farm operators.

$$TR_t = [(AGI * C_t - \text{Max}(ID_t - ZBA_t, ZBA_t) - PE_t * P_t) * t_t + \text{Min}(AGI * C_t, SSB_t) * r_t - PVSEB_t - ITCR_t]/(AGI * C_t).$$

Where

$ITCR$ = investment tax credit adjustment,
TR = effective federal tax rate,
AGI = adjusted gross income in base year,
ID = itemized deduction levels for corresponding income levels,
P = number of personal exemptions,
PE = personal exemption values,
C = consumer price index,
r = self-employment tax rate,
SSB = maximum self-employment wage base,
t = income tax rate schedule,
ZBA = zero bracket amount or standard deduction where applicable,
$PVSEB$ = present value of expected future Social Security benefits from current contributions.

The consumer price index (CPI) for the years 1970–90 is incorporated in the model (Table 1). Changes in the CPI during the period approximate changes in the net farm income (USDA 1987). On average, net farm income rose by 94 percent of the CPI change during the period. The above equation accounts for the Internal Revenue Service's annual estimates of individual taxpayer itemized deductions by adjusted gross income levels. The tax rate schedules for the years 1970–90 are incorporated in the model as are all variations in the treatment of the standard deduction versus the itemized deduction. For example, in 1987–90 the greater of the standard deduction or itemized deductions reduces AGI. That contrasts with prior periods where the zero bracket amount was accounted for in the rate schedules and only excess itemized deductions reduced AGI. The model also accounts for the deduction against AGI of one-half of the self-employment tax paid in 1990. The present value of expected future Social Security benefits from current contributions is incorporated in the model as a potential reduction in the effective tax rate. The value of *PVSEB* is dependent on numerous factors such as age, marital status, self-employment earnings level, number of years of employment, and others. For purposes of this study, PVSEB is set at 30 percent for $25,000 AGI, 20 percent for $45,000 AGI, and 15 percent for an AGI of $60,000 or more (Boskin et al.).

An investment tax credit factor is also included to capture its relative significance in reducing farm operator tax liabilities. Because estimation of investment credit by income level is difficult, the amount of investment credit claimed in post-1971 and pre-1986 years for the sector as a whole is allocated among the income groups on a proportionate basis.

It is assumed that farm operators utilize all available deductions in arriving at AGI. The model, however, does not account for the myriad of changes in the tax law in regards to alternative depreciation techniques, accounting methods, or income and expense recognition options. Adjusted gross income is used as a proxy for income subject to self-employment tax.[4] This proxy

[4]The true basis for the self-employment tax is net farm income rather than adjusted gross income. However, for most low- and middle-income farm households, the AGI generally approximates the self-employed or the combination of self-employed and employee gross income. The maximum wage base for self-employment taxes is low enough that most outside sources of income (for example, rents, royalties, interest, dividends, capital gains, among others) will not be significant for those whose AGI is under the maximum wage base. In addition, even where farm operators have other than self-employed income, there are sources of income that are income tax deferred but still includable in determining the self-employment tax base (KEOGH plans, IRAs, among others). The net effect, over the relevant range is to enable AGI to be a reasonable estimation of self-employment income.

is generally reasonable given that most farm operators with less than the maximum income subject to employment taxes have fewer opportunities to reduce AGI through tax shelters and other techniques. However, when assessing farm operators with nonfarm employee(s) income, the maximum wage base needs to be modified where the combination of spouses' incomes exceeds the maximum employment wage base for a single wage earner. This will often occur when the farming operation is heavily subsidized with off-farm employment.

Data

Adjusted gross income is adjusted annually by changes in the CPI with 1967 being the base year. Itemized deductions by differing income levels were obtained from the Internal Revenue Service. The annual itemized deduction data were divided into interest, medical, taxes, and contributions. The itemized deduction data are not separated between farm and nonfarm taxpayers. Therefore, itemized deductions included in the model are representative of all taxpayers in each income category. Actual tax rates, tax brackets, zero bracket amounts, standard deductions, and personal exemption values for the years 1970–90 were obtained from the Internal Revenue Code. Five different adjusted gross income levels were addressed in this study. The $25,000 (1986 dollars) level represents low-income farm families where the self-employment tax liability is generally greater than the income tax liability. The $40,000 and $60,000 income levels represent middle-income farm families and show the direct relationship between increasing income and the employment and income tax liabilities. The $85,000 and $150,000 levels were utilized to focus on the decreasing impact of self-employment taxes relative to income taxes on high-income individuals.

Even with the net farm losses reported on Schedule F for the years 1981–86, self-employment taxes for farm operators during the period were several billion dollars. For those profitable farm operators, the adjusted gross income figure will likely approximate self-employment earnings. There are, of course, exceptions such as timber and breeding stock, where capital gain income is not subject to self-employment taxes. That income is also not reported on Schedule F.

Results

Figure 1 shows the federal income and self-employment tax incidence for married farm operators filing a joint return and claiming itemized deductions and four personal exemptions for the years 1970–90. The impact of "bracket creep" for the years 1970–81 is clearly shown in Figure 1. Farm operators with no real income changes were pushed into higher tax brackets because of increasing nominal income. The imposition of inflation-adjusted tax brackets and rates in 1981 initiated the decline in effective tax rates.

The sharp increases in effective tax rates from 1979 to 1981 reflect a period of high inflation. The 23 percent reduction in tax rates provided by ERTA is clearly manifest in the dramatic drop in effective tax rates from 1981 to 1984.[5] The relatively stable years 1984–86 show only inflation adjustments to income taxes. Again, the sharp decline in effective tax rates from 1986 to 1988 coincides with the enactment of TRA of 1986. Here, marginal tax rates were cut, tax brackets were significantly widened, and exemption values were nearly doubled.

Coupled with the dramatic decline in marginal tax rates was the repeal of investment credits. The effective tax rates for post-1985 tax years reflect an overall decline from pre-1986 levels even with elimination of the investment credit. The amount of investment credit reduction in the applicable years was 10 percent of tax liability.[6]

[5]ERTA phased in a 23 percent marginal tax rate reduction over a four-year period. The rate reduction affected 1981 taxable income by applying a credit of 1.25 percent to the tax computed on 1981 income. The cumulative effect of the rate reductions was 10 percent in 1982, 19 percent in 1983, and 23 percent in 1984. For tax years beginning in 1985, the individual income tax brackets, zero bracket amount, and personal exemptions were adjusted for inflation based on the CPI.

[6]The 10 percent reduction in tax liability was based on a study that determined that annual investment credit accounted for nearly 10 percent of farm operator tax liability in the 1975–84 period. An exception was found for small farmers who in many cases had a higher ratio of investment credits to income tax liability (Nixon and Richardson 1988).

Figure 1. Federal Tax Incidence for Various Income Levels with Self-Employment Taxes

Lower- and middle-income farm families are, in real terms, worse off after two decades of tax law manipulation. While there has been a decline in income tax obligations for all groups, lower- and middle-income farm families are relatively disadvantaged through significant increases in self-employment taxes. For higher-income individuals the self-employment tax is generally only a minor part of their overall tax liability. In fact, during the 1980s there has been a narrowing of the effective rate differential among different farm income groups. In 1981, for example, the difference between the effective rate for high- and low-income farm familes was more than 11 percent. By 1990 this difference will have decreased to less than 10 percent.

The combination of income tax decreases and self-employment tax increases will, by 1990, cause a farm operator with adjusted gross income of $46,805 ($40,000 in 1986) to pay a greater real share of his adjusted gross income in federal tax payments than a farm operator with $99,513 ($85,000 in 1986) of AGI (Figure 1). Similarly, beginning in 1987, farm operators in the $40,000 (1986) AGI bracket pay nearly the same share (within 3 percent) of their income in federal taxes as those in the $150,000 (1986) AGI bracket.

Ignoring the impact of self-employment taxes, the effective federal tax rate in 1990 for all farm operator income groups will approximate that of 1970 (Figure 2). All income farm groups realized significant increases in effective income tax rates during the 1970s followed by rapid declines in the 1980s. The 1987–90 period is generally one of constancy with only tax brackets, exemptions, and standard deductions adjusted for inflation.

Summary and Conclusions

A simulation model was used to determine the effective marginal tax rates for profitable married farm operators filing joint returns by varying income levels during the 1970–90 period. Farm operators' income tax and self-employment tax liabilities were combined to determine tax incidence. Five

Figure 2. Federal Tax Incidence for Various Income Levels without Self-Employment Taxes

inflation-adjusted income levels were used to track real changes in tax incidence.

Although numerous changes occurred in the federal income and self-employment tax laws during the 1970–90 period, the net effect for high-income farm families is that effective rates in 1990 are surprisingly similar to rates in 1970. All other farm families will have realized an increase in their effective tax rates during the same period. While the 1970s represented a period of rising real tax rates for all income levels, the income tax legislation of the 1980s has, for the most part, reversed the trend of the early 1970s and decreased income tax incidence to the early 1970 level. Although middle- and low-income farm families have benefited from post-1980 income tax legislation (Figure 2), the imposition of increased employment taxes has offset some of the income tax gains.

A limitation of the study is that the model does not account for all changes in the tax law affecting farm operators during the 1970–90 period. While the elimination of capital gains and numerous other provisions does not generally affect self-employment taxes, it does impact on farm operator income tax liabilities. The lower marginal tax rates of the late 1980s is partly in response to the elimination of investment credit and capital gains deductions. There are, however, potential problems in assigning capital gains income by farm income group. For example, livestock operators typically have a greater capacity to utilize capital gains provisions than crop farmers. Similarly, the type of farming operation generally dictates to what extent investment credits are available. Highly mechanized farming operations would have greater credits than labor intensive operations. Therefore, to generalize the

results of the model, the above changes are not included. Additional research can address those problems by focusing on types of operations rather than on income.

For federal tax policy in the 1990s, self-employment tax receipts will continue as an important source of government revenue. Increasing self-employment taxes will continue to be the pattern in order to meet the income needs of a progressively older, retired population. If increases in income taxes do not occur and self-employment tax obligations continue to rise at projected rates, federal tax incidence will continue to grow for low- and middle-income farm families and be relatively constant for high-income farmers. If policy makers believe higher-income taxpayers should have a greater tax incidence than lower-income taxpayers, future tax law changes will require more progressive elements in the income tax structure to offset projected self-employment tax increases.

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Interest Rate Risk Exposure of Agricultural Banks: A Gap Analysis

Paul N. Ellinger and Peter J. Barry

Abstract

Interest rate risk in commercial banks can occur when the maturity structures of a bank's assets and liabilities are different. Measuring gap is one way of observing the interest rate exposure of banks. This paper examines a sample of banks cross-sectionally to explore the range of gap measures among banks of different sizes, legal structure, and agricultural dependence. Results indicate that gap measures for banks as a whole are consistent with expectations, but there is evidence that a portion of agricultural banks have significantly high or low gap measures, thus showing more vulnerability to unexpected changes in market interest rates.

Key words: interest rate risk, gap, vulnerability, agricultural banks.

The removal of interest rate ceilings on deposits and the effects of financial stress in agriculture combined to substantially diminish the profitability of agricultural banks in the 1980s, increase bankruptcies, and place more agricultural banks on the regulators' problem list (Melichar; Melichar and Irwin; Belongia and Gilbert). Moreover, those causal factors are interrelated because many banks responded to interest rate deregulation by passing the higher, more volatile cost of funds on to borrowers through floating rate loans and other repricing methods. The transfers of interest rate risks increased financial risk for many borrowers and then affected the agricultural banks through higher lending risks, loan delinquencies, greater loan losses, and increased administrative costs, thus contributing to the downturn in profitability. Despite improvements in the financial outlook for agriculture in the 1990s, we note that interest rates remain relatively high and are subject to considerable uncertainty. Thus, responding to interest rate risk is an important part of asset-liability management for agricultural banks in their quest to be viable, competitive, and high performance agricultural lenders in the future.

Interest rate risk has two major effects on a bank's financial performance (Mitchell). The first—called income risk—involves the effects of unanticipated changes in interest rates on a bank's interest income, expenses, and net interest margin. The second—called investment risk—involves the effects of unanticipated changes in interest rates on the values of a bank's assets, liabilities, and net worth. In response to these effects, measures of "gap" and "duration gap" have been employed to gauge a bank's exposure to income risk and investment risk, respectively, and to consider strategies for responding to those sources of interest rate risk (Gardner and Mills).

Paul N. Ellinger is an agricultural economist, and Peter J. Barry is a professor of agricultural finance, both at the University of Illinois in Urbana-Champaign. The authors gratefully acknowledge the helpful review comments of an earlier draft from Morgan Lynge and from anonymous reviewers from *Agricultural Finance Review*. Any remaining errors are the author's responsibility.

Use of gap measures by bank managers and financial analysts is growing, especially in larger banking systems (for example, Baker; Binder; Kaufman). However, empirical analysis of gap positions has been rather limited. Several studies (Maisel and Jacobson; Flannery; Graddy and Karna) found that commercial banks as a whole have been relatively well hedged against interest rate risks. However, a large portion of the data used in those studies represents periods prior to 1980 when interest rates were more stable. Moreover, little is known about the gap positions of smaller banks, especially those heavily involved in agricultural lending. The smaller size, lower diversity, and more limited sources of funds for many of these banks reduce their options for responding to interest rate risks and heighten the need to generate information about their exposure to those sources of risk.

Investigating the vulnerability of agricultural banks to the income risk portion of interest rate risk in a volatile financial environment is the focus of this study. The basic procedure is to first rationalize the use of the gap measures by using historic call report data to evaluate changes in net interest margins for banks with high and low gap positions. Then, cross-sectional differences in gap positions are investigated according to differences in bank size, legal structure, repricing horizon, and involvement in farm lending. Characteristics of banks that exhibit high and low gap measures are also discussed. The following sections review the concepts of gap management, describe the data sources and analytical procedures, present the empirical results, and consider their implications.

Gap Concepts and Measures

The concepts and measures of gap and duration gap management for financial institutions are similar to those of liquidity management for other types of firms. A short-term planning horizon is established and the focus is on the balance between assets and liabilities that can be repriced within the planning horizon.

Duration gap management concentrates on insulating the market value of the institution's net worth from interest rate changes. For example, when the rate sensitivity of assets is greater than the rate sensitivity of liabilities, an unexpected increase (decrease) in interest rates will reduce (increase) the institution's net worth. The insulating approach, then, is to match the durations of the rate sensitive assets and liabilities.

Measuring duration involves the present values of maturity-weighted cash flows for each asset and liability, and frequent revisions of portfolio holdings are required in a more volatile interest rate environment. Given the complex measurement procedures and the limited amount of information available on bank call reports, estimating duration positions for financial institutions is difficult (French). Moreover, the smaller size and the greater concentration of ownership of smaller agricultural banks suggest a relatively greater focus by bank management on the stability of net operating margins relative to net worth (Mitchell). Thus, in this study we will concentrate on measuring some of the commonly used gap measures of income risk in order to assess the vulnerability of agricultural banks to this portion of interest rate risk.

Gap management examines how changes in interest rates affect a financial institution's net interest income. The gap measures may be expressed as absolute dollar values or as ratios (similar to measures of working capital and current ratio used in liquidity analysis). The gap measures employ the concepts of rate sensitive assets (*RSA*) and rate sensitive liabilities (*RSL*). Those assets and liabilities either mature or can be repriced within the planning horizon used in asset-liability management (Mitchell; Sinkey; Gardner and Mills). Examples of rate sensitive assets include federal funds sold, maturing and floating rate loans, and securities maturing or purchased under resale agreements. Rate sensitive liabilities include federal funds purchased, maturing or floating rate time deposits, securities sold under repurchase agreements, and other liabilities subject to repricing within this time period.

Gap can be measured as the difference between rate sensitive assets and rate sensitive liabilities

$$GAP\ \$ = RSA - RSL \quad (1)$$

or, as the ratio of rate sensitive assets to rate sensitive liabilities

$$GAP\ ratio = RSA / RSL \quad (2)$$

The gap ratio approach is the more general measure and allows comparisons of gap positions among institutions of different size.

Another commonly used ratio in asset-liability management is the ratio of the difference between rate sensitive assets and liabilities to earning assets employed by the bank

$$GAP\ to\ EA\ ratio = \frac{(RSA - RSL)}{earning\ assets} \quad (3)$$

The gap-to-earning assets ratio may be a more valid indicator of vulnerability to interest rate risk when the proportions of assets and liabilities that are rate sensitive are small.

Theoretically, a bank's net interest margin is insulated from interest rate risk when the gap ratio equals 1 or when the dollar value of gap is 0. Under those conditions changes in interest rates should have offsetting effects on the revenues and costs of assets and liabilities, so that the net interest margin is stabilized. The effect is to achieve a perfectly (or nearly so) positive correlation between returns on assets and the costs of liabilities over the planning horizon in question. That strategy would only be modified if trends in interest rates were anticipated. For example, an up-swing in interest rates suggests that the gap ratio should exceed 1; more assets then would be repriced than liabilities, thus increasing the net interest margin. An anticipated downward trend in interest rates would suggest a gap ratio of less than 1. Of course, in an efficient financial market, trends in interest rates are difficult to anticipate.

The concepts and measures of gap are relatively simple and straightforward to employ; however, like other widely used financial ratios, the gap approach has several significant shortcomings. Neither rate sensitive assets nor rate sensitive liabilities are homogeneous within their respective categories so that the interest rates on the financial instruments involved do not move perfectly together. Repricing opportunities within the planning horizon may differ as well, especially as the planning horizon lengthens. Thus, the choice of planning horizon (for example, one month, three months, six months) is important. In addition, changes in net interest margins resulting from adjustments in the volume and mix of earning assets and interest-bearing liabilities are not accounted for by the gap measures.

Competitive and structural characteristics of banks may influence gap strategies as well. For example, competition may force a bank to not reprice assets as much as desired or a bank may have to pay more for funds than desired. A manager of a small bank might choose to maintain a gap ratio greater than 1 because the bank has less control over the cost of funds, but can adjust the return on loans. On the loan side, the smaller agricultural bank may be facing imperfect markets due to strong customer relationships and fewer loan sources available, while the market for sources of funds could be more competitive (Barnard and Barry).

Despite those limitations, the gap concepts and measures play an important role in asset-liability management by financial institutions, and contribute significantly to structuring assets and liabilities so as to stabilize net interest margins and respond to interest rate risks. The measures serve as important signals to potential problems if interest rates change unexpectedly, and they contribute to strategic financial planning. Moreover, once the basic portfolio structure is established, other methods of responding to interest rate risks can be employed.

Data Sources

The data used in this study come from the call reports (income statements and balance sheets) submitted by U.S. commerical banks to the Federal Deposit Insurance Corporation (FDIC) as a part of its regulatory reporting requirements. In this study, banks are divided into agricultural and nonagricultural categories and further categorized by size of total assets and

affiliation with a holding company. Consistent with Melichar's approach, agricultural banks are defined as those banks whose ratio of farm loans to total domestic loans exceeds the unweighted average of such ratios at all banks.[1]

Beginning in 1983, banks were required to report maturity and repricing information for selected assets and liabilities, thus facilitating the measurement of rate sensitive assets and liabilities. Rate sensitive assets, as defined in this study, include accruing loans and lease financing receivables, debt securities, interest-bearing balances due from depository institutions, federal funds sold, and securities purchased under agreement to resell. Rate sensitive liabilities include time deposits, money market deposit accounts (MMDA), federal funds purchased, securities sold under agreements to repurchase, other borrowings, and notes and debentures subordinated to deposits. In each case the maturities of the assets and liabilities are either shorter than the specified repricing horizons or the assets and liabilities are subject to rate repricing within the horizon.

Consistent with other gap studies (for example, Gardner and Mills; Lynge), the rate sensitive liabilities exclude other demand deposits, savings accounts, and NOW accounts. Previous findings (Flannery and James) suggested that holdings of demand, savings, and small time deposits are relatively insensitive to interest rate changes and thus should be considered "long" or rate insensitive liabilities. In contrast, other studies (for example, French; Sheshunoff Information Services) have included NOW accounts in rate sensitive liabilities. Accordingly, the gap measures are modified to include NOW and super NOW accounts in portions of the analysis.

[1]An agricultural bank is defined as one whose ratio of farm loans to total loans exceeds the unweighted average for all banks in the year in question. Farm loans are the sum of *loans secured by farm real estate* and *loans to finance agricultural production and other loans to farmers* as reported on the FDIC call and income reports. The average farm loan ratios for each time period of this study are as follows: December 1984, 16.97 percent; June 1985, 16.82 percent; December 1985, 16.14 percent; June 1986, 16.22 percent; December 1986, 15.40 percent; June 1987, 15.96 percent; and December 1987, 15.55 percent.

Three repricing horizons are used in the study to provide greater generality to the results and because the actual repricing horizons used by banks are unknown. The repricing horizons are zero to three months (gap3), zero to six months (gap6), and zero to twelve months (gap12). However, because of similarities in results, only the gap3 and gap6 measures are reported below.

The data set covers the semiannual call reports from December 1984 through December 1987. The complete data set is used to identify possible relationships over time between the gap measures, changes in interest rates, and net interest margins. Year-end 1987 data are used for the cross-sectional comparisons between agricultural and nonagricultural banks and for analyzing the portfolio characteristics of agricultural banks.

Overview

Table 1 reports a semiannual time series of measures for interest income, interest expense, net interest margin, market interest rates, and gap positions for agricultural banks for 1984 through 1987. The mean six-month annualized interest income declined from 12.67 percent in December 1984 to 9.75 percent in June 1987 and then increased to 9.88 percent in December 1987. Interest expense exhibited a similar pattern, as did the average interest rate on federal funds, which represents the measure of market interest rates. The short-term median gap ratios are also relatively close to 1 over the same period (except for June 1987). As a result, net interest margin remained relatively stable, fluctuating from a high of 4.97 percent in June 1985 to a low of 4.48 percent in June 1987, or a range of 0.49 percent. Similar to previous findings for commercial banks in general, the data suggest that agricultural banks in aggregate have largely insulated net interest margins from changes in market interest rates.

Gap and Net Interest Margins

In order to evaluate the sensitivity of net interest margins to a bank's gap position, the first step is to observe the changes in net interest margins for banks with high and

Table 1. Measures for Gap, Interest Income, and Expense and Interest Rates for Agricultural Banks, 1984–87

	12/84	6/85	12/85	6/86	12/86	6/87	12/87
Number of Agr. Banks	4,930	4,934	4,791	4,770	4,634	4,607	4,443
Mean (Annualized Rates)[a]							
Interest Income (te)[b]	12.67%	12.17%	11.66%	11.08%	10.75%	9.75%	9.88%
Interest Expense	7.84%	7.19%	6.72%	6.31%	6.02%	5.27%	5.34%
Net Interest Margin (te)	4.82%	4.97%	4.95%	4.76%	4.73%	4.48%	4.55%
Average Fed. Funds Rate[c]	10.38%	8.22%	7.97%	7.45%	6.15%	6.54%	6.88%
Median							
Gap3 Ratio	1.001	0.930	1.068	0.936	1.035	0.867	0.936
Gap6 Ratio	0.949	0.959	1.018	0.947	0.985	0.881	0.914
Gap12 Ratio	1.063	1.080	1.084	1.053	1.061	0.983	1.026

[a]All variables are expressed as a percentage of average earning assets net of nonaccrual loans. Average earning assets are computed from beginning and end of period. Data include only banks that are in operation for the entire year.

[b]Interest income is calculated on taxable equivalent basis. For each bank with income before taxes greater than zero, income from state and local obligations was increased by $[r/(1-r)]$ times the lesser of income before tax or interest earned on state and local obligations, where r is the marginal federal income tax rate.

[c]The twenty six-week average of the weekly federal funds rates. Weekly figures are the averages for statement week ending Wednesday, where the rate for a weekend or holiday is taken to be the rate prevailing on the previous business day.

low gap ratios. According to the previous assumptions, banks with gap ratios that deviate substantially from 1 will be more vulnerable to movements in market interest rates than banks with gap ratios close to 1. Banks with high gap ratios are vulnerable to a decline in market rates while banks with low gap ratios are vulnerable to an increase in market rates. Observing changes in net interest margins at banks with different gap positions during periods of rising and falling interest rates should test the relationships.

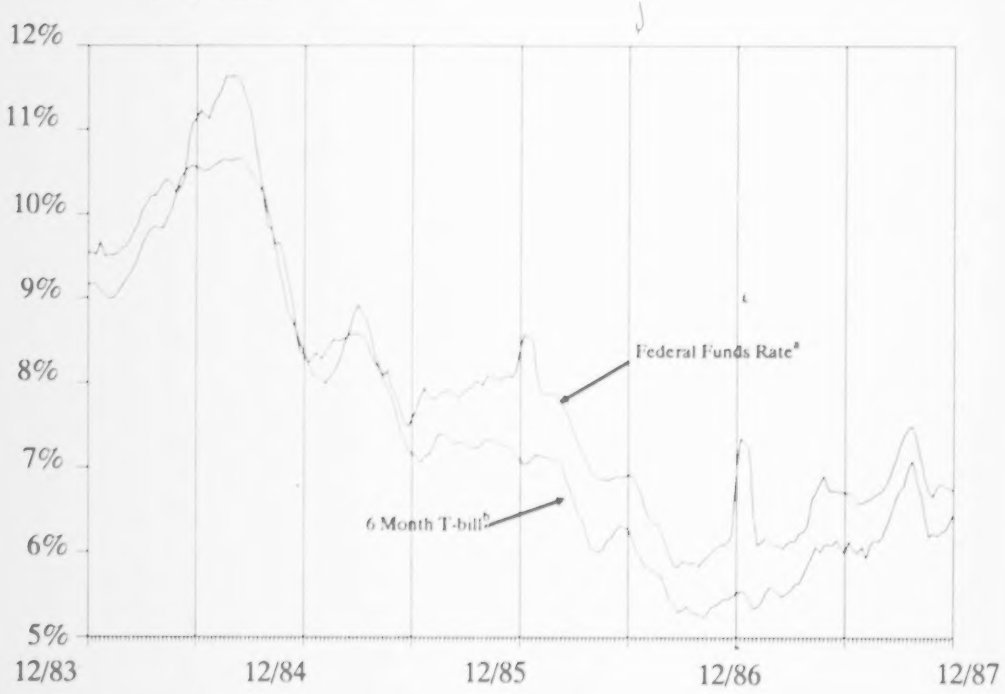
Figure 1 shows a four-week moving average of the weekly federal funds rate and the weekly six-month Treasury bill rate for 1984 through 1987. Those rates provide indicators of changing earnings on investment opportunities and cost of funds for the banks in question (Mitchell). Interest rates declined for the period December 1985 to June 1986 and showed a general increase from June 1987 to December 1987. The two six-month intervals are used as periods of falling and rising interest rates, respectively. The gap6 ratio is measured for each agricultural bank at the beginning of those periods.[2] The banks then are separated into four classes based on the size of their gap6 ratios. The mean changes in net interest margins for each six-month period relative to the preceding six-month period then are calculated for each gap class, as reported in Table 2.

For the declining rate period (December 1985 to June 1986) the mean change in net interest margin from the previous six months shows a greater decline for banks with high gap6 ratios than for banks with low gap6 ratios. The mean changes in net interest margins for banks with gap ratios less than 0.81 is −5.37 basis points while the change in interest margin for banks with gap6 ratios greater than 1.2 is −31.73 basis points. The mean change in net interest margins for all banks from December 1985 to June 1986 is −18.96 basis points. In contrast, during the increasing rate period (June 1987 to December 1987), the mean change in net interest margin increases as the gap6 ratio increases. Those means are 3.33 basis points and 13.61 basis points for banks with gap6 ratios less than 0.81 and greater than 1.2, respectively. The mean change in interest margin for all banks over the period is 7.12 basis points.

The results from those periods are roughly consistent with expectations, that is, high gap banks are more vulnerable to decreasing interest rates while low gap banks are more vulnerable to rising interest rates. The consistency is not complete, however, because in a rising interest rate environment the high gap banks (greater than 1) would be expected to have increasing net interest margins, while lower

[2]Only banks that are included in both periods (December 1985 to June 1986 and June 1987 to December 1987) are used in the sample.

Figure 1. Federal Funds Rate and Six-Month T-bill Rate, Four-Week Moving Average of Weekly Rates



[a] Weekly federal funds figures are averages for the statement week ending Wednesday.

[b] Treasury bill three-month auction average. Yields are quoted on a bank-discount basis. Rates are recorded in the week in which bills are issued.

Source: *Federal Reserve Bulletin*, Board of Governors of the Federal Reserve System, Washington, D.C., various issues.

gap banks (less than 1) would have decreasing net interest margins. Similarly, in a decreasing rate period, high gap banks should have decreasing margins and lower gap banks should have increasing margins. However, the measurement approach in this study only accounts for the gap position at one point in time. In practice, transactions involving only a few large loans or deposits could easily change the gap position at a small bank in a short period of time. Moreover, the banks could quickly revise their portfolios and thus their gap positions, if they see interest rates moving against them. In fact, 74 percent of the banks with gap6 ratios greater than 1.2 reduced their gap position from December 1985 to June 1986 while 73 percent of the banks with gap6 ratios less than 0.81 increased their gap position from June 1987 to December 1987.[3] Thus, the results do not necessarily suggest that changes in net interest margins are caused by the gap position, but they do indicate that the gap level may place a bank in a more vulnerable position as market interest rates change.

The preceding analysis can be extended by observing changes in net interest margins for banks that consistently have either high or low gap measures over the time period of the study. Accordingly, Table 3 indicates comparisons of the changes in interest margins for banks with gap6 ratios greater than 1.2 in *each* period with banks having ratios less than 0.81 in *each* period, over the full time horizon of the study.

[3]Banks in the three other gap classes did not change their gap position in any distinct pattern.

Table 2. Net Interest Margin Change by Gap Ratio Classification

	Net Interest margin (NIM) Change			
	12/85 to 6/86 *(decreasing market rates)*		6/87 to 12/87 *(increasing market rates)*	
	Number of Banks	Mean Change NIM[a] *(basis points)*	Number of Banks	Mean Change NIM *(basis points)*
Gap6 Ratio				
Less Than 0.81 (a)	887	−5.37 bcd[b]	1,537	3.33 d
0.81 to 1.00 (b)	1,042	−16.97 ad	1,027	7.25
1.01 to 1.20 (c)	878	−19.25 ad	612	8.83
Greater Than 1.20 (d)	1,089	−31.73 abc	720	13.61 a
All Banks	3,896	−18.96	3,896	7.12

[a]Mean annualized change of net interest margin from the previous six-month period (basis points; 100 basis points = 1 percent).

[b]Letters indicate mean significant difference (95 percent level) between banks of different gap6 ratio classes.

Example: bc in row (a) (less than 0.81) indicates that the mean value in row (a) (less than 0.81) is significantly different from mean values in rows (b) (0.81 to 1.00) and (c) (1.01 to 1.20) at the 95 percent confidence level.

Except for the June 1985 to December 1985 period, the mean change in net interest margin is significantly different between the high gap and low gap banks. As shown in Figure 1, the June 1985 to December 1985 period exhibits the smallest variation in interest rate movements among the various six-month periods. In times of rising interest rates, December 1986 to June 1987 and June 1987 to December 1987, the mean change in net interest margin is significantly lower for the low gap banks. In contrast, in times of falling market rates, December 1984 to June 1985, December 1985 to June 1986, and June 1986 to December 1986, the mean change is significantly lower for high gap banks. The high gap banks tend to be small, agriculturally dependent banks. Over 75 percent of the high gap banks have assets below $25 million with more than 56 percent of the high gap banks having farm loan ratios greater than 0.5. The asset size and farm loan ratios of the low gap banks are similar to the characteristics of all agricultural banks in 1987.

Table 3. Mean Change in Net Interest Margin[a] High and Low Gap Banks 1984–87[b]

	Mean Change in NIM *(basis points)*		
	High Gap >1.20	Low Gap <0.81	Interest Rate Environment
Number of Banks	220	303	
12/84 to 6/85	−21.65	41.15*	*Falling*
6/85 to 12/85	1.23	3.87	*Stable*
12/85 to 6/86	−44.67	−6.70*	*Falling*
6/86 to 12/86	−20.13	10.13*	*Falling*
12/86 to 6/87	−20.35	−37.43*	*Rising*
6/87 to 12/87	21.25	−6.20*	*Rising*

*Indicates mean significant difference between high and low gap banks at 95 percent confidence level.

[a]Mean annualized change of net interest margin from the previous six-month period (basis points; 100 basis points = 1 percent).

[b]*High gap* banks are banks that have gap6 ratios above 1.2 in *each* period from December 1984 to December 1987. *Low gap* banks are banks that have gap6 ratios below 0.81 in *each* period.

Again, the results are consistent with the anticipated relationships; during times of rising interest rates, low gap banks exhibit more interest rate vulnerability, while high gap banks tend to show more vulnerability in declining rate periods. Moreover, during stable rate periods, the gap position has relatively small effects on the ex post changes in net interest margins, as measured here.

Gap Measures 1987

Table 4 indicates the 1987 mean gap ratios under the two repricing horizons for banks classified by bank type and asset size.[4,5] The number of banks in the U.S. at year-end

[4]The gap_{now} ratios are calculated for each repricing horizon. The gap_{now} ratios are all smaller than gap ratios because the denominator of the ratio is larger by the amount of the NOW accounts, but the gap_{now} ratios exhibit similar patterns as the gap ratios.

[5]The gap12 ratio is measured but not reported here. The ratio exhibits similar trends as the gap3 and gap6 ratios. The standard deviation of the gap12 ratios are slightly smaller and the mean values are closer to 1.

1987 totaled 13,217 with 4,443 classified as agricultural banks and 8,774 as nonagricultural banks. Most of the agricultural banks are found in the smaller size categories (less than $50 million in total assets). The key comparisons in Table 4 are between the gap ratios for agricultural banks versus nonagricultural banks within the respective size categories and repricing horizons. In all but two cases, the mean gap ratios are lower for agricultural banks than for nonagricultural banks. Exceptions occur in the $300 million to $1 billion size category in which there are only four agricultural banks. Statistical tests indicate significant differences in the gap ratios between the agricultural and nonagricultural banks at the 95 percent confidence level in five of the ten cases. Within the repricing horizons the mean gap ratios are consistently the highest for the smallest size category (total assets less than $25 million) of banks. The mean gap ratios generally decline in the next two size groups but then increase for banks with assets greater than $100 million. All of the mean gap ratios are lower for the six-month repricing horizon than for the three-month horizon.

Considerable dispersion in gap ratios occurs within each category, as indicated by the standard deviations reported in Table 4. The dispersion is especially high in the smallest size category (less than $25 million) with standard deviations exceeding the mean values for each type of bank and repricing horizon. In the case of agricultural banks, the standard deviation for those banks with less than $25 million in total assets is almost five times larger than that of all agricultural banks with assets greater than $25 million.

Table 5 reports selected financial characteristics of banks at year-end 1987 for the different size categories. The data provide some evidence about the portfolio characteristics of the smallest size category of banks that has the significantly higher mean gap ratio. In particular, those banks have the lowest mean ratio of loans to total rate sensitive assets and the highest ratio of other rate sensitive assets (federal funds sold, interest bearing balances due from depository institutions, and securities purchased under agreement to resell) to total rate sensitive assets. They also have the lowest ratios of money market deposits and large time deposits to total rate sensitive liabilities and the highest ratio of other time deposits to total rate sensitive liabilities. At the same time, the mean ratios of total rate sensitive assets to total assets for banks with assets greater than $25 million and less than $100 million are essentially the same. This ratio is slightly larger for banks with assets less than $25 million and for banks with assets greater

Table 4. Mean Gap Ratios by Bank Type, Bank Size, and Repricing Horizon, 1987

Bank Size	Number of Banks		Gap3 Ratio		Gap6 Ratio	
	Non-Agr.	Agr.	Non-Agr.	Agr.	Non-Agr.	Agr.
Less Than $25M	1,936	2,319	1.325 [+]	1.249 [+]	1.163 [+]	1.098 [+]
			(1.9906)[a]	(2.2272)	(1.4526)	(1.5278)
$25 to $50M	2,193	1,335	1.103 [+]	1.027*	1.025 [+]	0.945* [+]
			(0.6520)	(0.8927)	(0.4991)	(0.3479)
$50 to $100M	2,135	646	1.061 [+]	0.954* [+]	0.989	0.900* [+]
			(0.5141)	(0.3626)	(0.3968)	(0.2739)
$100 to $300M	1,663	139	1.086 [+]	1.030	1.013	0.938* [+]
			(0.4461)	(0.3238)	(0.3651)	(0.2518)
$300 to $1,000M	509	4	1.104 [+]	1.187	1.011	1.036
			(0.8691)	(0.3994)	(0.3439)	(0.2766)
Greater Than $1,000M	338		1.105		1.040	
			(1.7515)		(1.1862)	
All Banks	8,774	4,443	1.138 [+]	1.133 [+]	1.044 [+]	1.018
			(1.1197)	(1.6928)	(0.8101)	(1.1291)

*Indicates mean significant difference between agricultural and nonagricultural banks of the same size class at the 95 percent confidence level.

[+] Indicates that mean is significantly different from 1 at the 95 percent confidence level.

[a]Standard deviations are given in parentheses.

Table 5. Selected Financial Characteristics of Agricultural Banks by Asset Size, Mean Values, December 1987

	Bank Size			
	<$25M (a)	$25–50M (b)	$50–100M (c)	$100–300M (d)
Number of Banks	2,319	1,335	646	139
Gap6 Ratio	1.098	0.945	0.900	0.938
	bcd[a]	ac	ab	a
Gap6 Earning Assets	−1.42%	−3.81%	−5.56%	−3.41%
	bc	ac	ab	
Gap6 Earning Assets (absolute)	12.63%	11.24%	10.96%	9.76%
	bcd	a	a	a
Percent Banks Gap6 Ratio >1.20	23.9%	17.2%	13.6%	14.4%
	bcd	ac	ab	a
Percent Banks Gap6 Ratio <0.81	33.3%	38.3%	40.1%	31.7%
	bc	a	a	
Rate Sensitive Assets/Total Assets	0.386	0.377	0.372	0.390
	bc	a	a	
Rate Sensitive Assets Composition				
Loans	0.601	0.639	0.645	0.709
	bcd	acd	abd	abc
Securities	0.164	0.164	0.176	0.138
	d	d	d	abc
Other	0.235	0.197	0.179	0.154
	bcd	acd	abd	abc
Rate Sensitive Liabilities Composition				
MMDAs	0.230	0.272	0.283	0.288
	bcd	ad	a	ab
Large Time Deposits	0.119	0.127	0.140	0.170
	bcd	acd	abd	abc
Other Time Deposits	0.643	0.593	0.559	0.514
	bcd	ad	ad	abc
Other RSL	0.008	0.008	0.017	0.028
	cd	d	ad	abc

[a]Letters indicate mean significant difference (95 percent level) between banks of different size classes.

Example: bc in column (a) indicates that the mean value in column (a) (<$25M) is significantly different from the mean values in column (b) ($25–50M) and column (c) ($50–100M).

than $100 million. Thus, the higher gap position of the smallest size category of agricultural banks appears attributable to relatively less involvement in loans and large time deposits. The absolute portion of the gap-to-earning asset ratio is measured without regard to the sign of the gap position. Thus, the measure gives the proportion of earning assets that are mismatched under each gap horizon. It gives a better measure of the potential vulnerability of a group of banks because it eliminates the offsetting effects of positive and negative values when mean gap ratios are calculated. Consistent with the gap ratio, both the gap-to-earning assets ratio and the absolute gap-to-earning assets ratio trend downward as bank size increases.

In terms of bank structure, Table 6 indicates gap measures and portfolio characteristics under the gap6 horizon for agricultural banks that are owned by a multibank holding company (MBHC) versus banks owned by a single bank holding company or independent banks (SBHC). The object is to observe whether the policies of the holding company and the access to its resources and services are associated with any differences in the vulnerability of agricultural banks to interest rate risk, as measured by the gap ratio. The table is divided into asset size categories to reflect the previously observed effects of size on the gap ratios.

The mean gap6 (1.017) for banks with assets less than $25 million that are owned by a MBHC is significantly lower than the mean gap6 ratios for similar size banks that

Table 6. Selected Financial Characteristics of Agricultural Banks by Bank Structure and Size, Mean Values, December 1987

Total Assets ($1,000)	Less Than $25M		$25M–$50M		$50M–$100M		$100M–$300M	
Bank Structure	SBHC	MBHC	SBHC	MBHC	SBHC	MBHC	SBHC	MBHC
Number of Banks	1,952	367	1,049	286	484	162	79	60
Gap6 Ratio	1.114	1.017*	0.934	0.987*	0.889	0.931	0.916	0.967
Gap6/Earning Assets	−1.3%	−1.9%	−4.4%	−1.6%*	−6.1%	−3.8%*	−4.5%	−2.0%
Gap6/Earning Assets (Absolute Value)	12.7%	12.3%	11.5%	10.3%*	11.4%	9.6%*	9.7%	9.8%
Banks with Gap6 Ratio >1.20	23.9%	23.7%	16.5%	19.6%	13.2%	14.8%	10.1%	20.0%
Banks with Gap6 Ratio <0.81	33.0%	34.9%	40.5%	30.1%*	42.1%	34.4%	36.7%	25.0%
Rate Sensitive Assets/ Total Assets	0.387	0.376	0.373	0.389*	0.370	0.376	0.383	0.398
Rate Sensitive Assets Composition								
Loans	0.602	0.598	0.638	0.643	0.641	0.659	0.700	0.720
Securities	0.167	0.150*	0.164	0.165	0.182	0.159	0.148	0.123
Other	0.231	0.252*	0.198	0.193	0.177	0.183	0.152	0.156
Rate Sensitive Liabilities Composition								
MMDAs	0.226	0.253*	0.270	0.281	0.277	0.302*	0.273	0.308
Large Time Deposits	0.120	0.111	0.129	0.120	0.146	0.122*	0.185	0.150
Other Time Deposits	0.646	0.628	0.594	0.589	0.561	0.556	0.522	0.503
Other RSLs	0.008	0.009	0.008	0.011	0.016	0.020	0.020	0.038

*Indicates mean significant difference between SBHC (banks owned by a single bank holding company or have no bank holding company affiliation) and MBHC (banks held by a multibank holding company) of the same size category at the 95 percent confidence level.

are independent or are owned by a SBHC. The mean gap6 ratios for banks with assets greater than $25 million are higher for banks owned by a MBHC compared with SBHCs. MBHC banks consistently had higher proportions of MMDAs to total rate sensitive liabilities than single bank affiliates or independent banks. While some other significant differences occur, this is the only discernable pattern among these structural categories of banks.

Characteristics of High and Low Gap Banks

As discussed earlier, banks that have high or low gap positions may be more susceptible to unexpected interest rate changes. Observation of the characteristics of banks that exhibit those gap positions will identify what types of banks may be vulnerable to interest rate movements.

The numbers of agricultural banks exhibiting gap6 ratios below 0.81 (low gap) and greater than 1.2 (high gap) on December 1987 are 1,530 and 893, respectively. The high gap banks tend to be small, agriculturally dependent institutions. Over 88 percent of the high gap banks have assets less than $50 million.[6] These banks have an average farm loan ratio of 46.1 percent, which is substantially higher than 42.8 percent for all agricultural banks of similar size. Geographically, a larger proportion of high gap banks are in agriculturally dominant states. Over 30 percent of small (<$25 million) agricultural banks in Nebraska, North Dakota, Missouri, South Dakota, and Wisconsin have gap6 ratios greater than 1.2. In contrast, the distribution of low gap banks by size is similar to the distribution of all agricultural banks. The low gap banks tend to be in more economically diverse regions. Over 40 percent of all agricultural banks in Arkansas, Illinois, Iowa, and Oklahoma have gap6 ratios less than 0.81. In terms of bank structure, there is no discernible pattern between MBHC and SBHC for high and low gap banks.

After controlling for bank size, characteristics of high, middle, and low gap banks are observed. Consistent patterns

[6]Banks with assets less than $50 million comprise 82 percent of all agricultural banks.

Table 7. Characteristics of High, Middle, and Low Gap Agricultural Banks With Assets Less Than $25M, Mean Values, December 1987

Gap6 Ratio	Low <0.81 (a)	Middle 0.81–1.20 (b)	High >1.20 (c)
Number of Banks	748	1016	555
Farm Loan Ratio	0.420	0.457	0.486
	bc[b]	ac	ab
RSA[a]/Total Assets	0.279	0.402	0.499
	bc	ac	ab
Loan/Deposit Ratio	0.448	0.508	0.527
	bc	ac	ab
Securities/RSA[a]	0.175	0.160	0.157
	bc	a	a

[a]A six-month repricing horizon is assumed.

[b]Letters indicate mean significant difference (95 percent level) between banks of different gap6 ratio classes.

Example: bc in column (a) (low gap) indicates that the mean value in column (a) (low gap) is significantly different from mean values in columns (b) (middle gap) and (c) (high gap) at the 95% confidence level.

across all size groups occurred with four key ratios. The ratios and their mean values for banks with assets less than $25 million are reported in Table 7.[7] As discussed earlier, high gap banks have significantly larger farm loan ratios. High (low) gap banks also tend to have larger (smaller) ratios of rate sensitive assets to total assets and loans to deposits, while high (low) gap banks have a smaller (larger) proportion of securities to rate sensitive assets.

In summary, a large proportion of the high gap banks consist of small banks that are located in more remote agriculturally dependent areas. Walraven and Rosine reported that in 1987, 59 percent of all nonreal estate loans to farmers were variable rate. In addition, the average maturity of nonreal estate agricultural loans is approximately eight months. Consequently, banks in agriculturally dominant areas may be constrained to have a loan portfolio that is highly rate sensitive. The low gap banks tend to be more diversified and in areas that may be more competitive for loans (signalled by lower loan-to-deposit ratios). Thus, low gap banks have a high proportion of rate sensitive assets invested in securities and, hence, may be in a position to change their portfolio more readily than high gap banks as interest rates change.

[7]Mean values for the other asset size categories exhibited similar trends and, thus, are not reported here.

Concluding Comments

The analysis in this study of agricultural banks with high and low gap ratios confirms that a bank's gap position may affect its vulnerability to interest rate risk through its effects over time on the bank's net interest margin. But, those effects may vary considerably among individual banks.

The empirical results indicate that agricultural banks as a whole exhibit gap ratios close to the potentially stabilizing level of 1. On average, then, these gap ratios may help to insulate net interest margins from interest rate risk. Furthermore, affiliation with an MBHC has little influence on the relative gap position of agricultural banks, although some observable differences of mean gap measures occurred among banks of different size and degree of agricultural lending.

Despite those aggregate relationships, the results also indicate that considerable dispersion exists in the gap ratios of individual banks and thus in their vulnerability to interest rate risk. The dispersion is especially large in the case of smaller banks (that is, less than $25 million in total assets), where the number of agricultural banks is large (2,319 in 1987) and the standard deviations of the mean gap ratios exceed the mean values by relatively large amounts. Many of those banks are located in agriculturally dominant areas and thus must cope with the asset-liability management problems inherent in small rural communities, especially a less diverse loan market with relatively long-term, seasonal needs for funds and a potentially volatile source of deposit funds.

The results raise questions about the effectiveness of asset-liability management in those banks and the degrees of competitiveness in their local financial markets. They further suggest that more emphasis on responding to interest rate risks is needed for the smaller banks, especially in agriculturally dependent areas

where portfolio changes can occur rapidly. Moreover, due to size constraints or possibly lack of expertise, agricultural banks in general have not engaged in other interest rate management techniques such as interest rate hedges and swaps. Less than 1 percent of all agricultural banks report engaging in interest rate hedging or interest rate swaps.[8] Thus asset-liability management remains a primary method by which agricultural banks can cope with interest rate risk.

The gap positions at agricultural banks have been used to evaluate the vulnerability to the income risk portion of interest rate risk. It is not a conclusion that interest rate risk can be measured exactly by evaluating the gap position of a bank. Rather, exposure to interest rate risk may be higher as gap measures deviate substantially from the norm values. Extensions of the framework developed here might consider other factors affecting interest rate risk at commercial banks. Lynge shows, for example, how changes in the mix of earning assets to total assets and interest bearing liabilities to total liabilities affect interest rate risk. More detailed data also are needed to more accurately measure the interest rate exposure of commercial banks. Only rough estimates of the interest rate risk exposure at commercial banks can be produced with the information currently available through the FDIC.[9]

Another extension of the analysis might consider the investment risk portion of interest rate risk. Duration gap measures for agricultural banks could be estimated (French) and compared with gap measures reported in this study. The characteristics of banks that are vulnerable to investment risk could be then compared with those that are vulnerable to interest rate risk. Using a combination of gap and duration analysis one could test the interrelationships between the two models and more fully explain the total interest rate risk exposure of financial institutions.

[8]Based on the number of banks that reported futures and forward contracts (commitments to purchase or sell) or notational value of all outstanding interest rate swaps on the December 1987 FDIC call reports.

[9]This dilemma is compounded by the fact that much of the repricing information is no longer available as of March 1988.

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Credit Assessment Models for Farm Borrowers: A Logit Analysis

Lynn H. Miller and Eddy L. LaDue

Abstract

Farm size, liquidity, solvency, profitability, capital efficiency, and operating efficiency measures are used to develop credit scoring models for dairy farm borrowers. Weighted logit models are used to discriminate between acceptable borrowers and borrowers who have defaulted. Also, methodological issues that pertain to classification models (identifying the conditional probability model, selecting a classification cut-off point, and validating the model) are addressed. Results indicate that larger borrowers can be classified well using financial ratios. Ratios of importance were debt payments per dollar of milk sales, cash expenses before interest and taxes per dollar of gross income, and young stock per cow.

Key words: borrower classification, credit scoring, dairy farm, financial ratios, loan default, logit.

An important component of the total interest rate charged for a loan is the risk premium included to reflect the credit worthiness of the borrower (Federal Reserve Bank). A risk premium is usually charged to borrowers with a relatively high default potential because they may: (*a*) require above average servicing costs; (*b*) reduce expected profits because of loan restructurings at terms less favorable to the lender (Chesser); and (*c*) frequently cause loan losses stemming from total loan default (Federal Reserve Bank). Therefore, identifying existing borrowers who are more likely *not* to make timely payments in the forthcoming year is critical to a differential loan pricing program that adjusts the interest rate charged to a borrower throughout the life of the loan.

Objective statistical methods for identifying problem and acceptable farm borrowers have been proposed since the mid-1960s (Reinsel and Brake; Bauer and Jordon; Evans; Johnson and Hagan; Dunn and Frey; Hardy and Weed; Lufburrow et al.). Agricultural credit assessment models have been used to evaluate loan applications of potential borrowers (credit screening) or to evaluate the credit worthiness of existing borrowers (loan review). In either case, the results can be used in the pricing decision.

The purpose of this article is to discuss some methodological issues of importance in a credit assessment analysis and to present the results of an empirical study of dairy farm financial factors that are related to loan defaults of existing borrowers. For the loan review analysis, a logit model is used to relate loan default to financial ratios of existing dairy farm borrowers.

Methodological problems and issues that are discussed include: (*a*) the definition of the dependent variable for the loan review

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model; (*b*) the bias caused by an inappropriate statistical method used to estimate the classification model; (*c*) the bias caused by a nonrandom sample; (*d*) the methods used to reduce a list of financial factors that have been found significant in past studies, or are believed to influence borrower quality, to a manageable number of regressors; and (*e*) the model's classification ability. Inappropriate handling of those issues may have biased prior findings and may have resulted in misinterpretations of the effectiveness of models to correctly classify borrowers.

Following the discussion of methodological issues, we (*a*) specify the model used in the analysis, (*b*) discuss the data used in the analysis, (*c*) review the analysis of variance results that are used to reduce the array of financial variables to the set of explanatory variables for the logit analysis, and (*d*) present the results of the logit analysis conducted.

Methodological Concerns

Several methodological issues are important for a credit assessment study that classifies existing borrowers based on their level of default risk. One issue is the definition of the dependent variable. The definition of acceptable and problem borrowers used for this study is different than ones used in past agricultural credit scoring research. For this study, the definition of an acceptable and problem borrower is based on the observed payment performance of the loan for the year following the time period for which farm financial data are collected and, thus, is completely objective. Typically, past agricultural studies have defined borrowers as acceptable or problem based on loan officer or examiner classifications, which are somewhat subjective. Because examiner or loan officer classifications for specific borrowers would not necessarily be consistent between examiners, lenders, or time periods, measurement error may be encountered that would decrease the statistical fit and classification ability of the model.

Because of the different definition of a problem borrower used in this study, a problem loan for this study may have been classified as an acceptable credit using the examiner's classification. Also, a loan classified as a problem by the lender because of past repayment history and inadequate security could be classified acceptable for this study if the loan was paid as scheduled.

With both definitions, some problem loans will ultimately be paid in full—including accrued interest. The full payment of a borrower's obligation may be accomplished by the lender foreclosing and applying proceeds (from the sale of the collateral) to the outstanding debt if the collateral is adequate. Or the lender may reschedule the outstanding principal and accrued interest in a manner that allows the borrower to pay back the debt under new terms. Last, a problem borrower may "catch up" on delinquencies and make future installments as originally scheduled.

The strength of this study's definition of acceptable and problem borrowers is that it is objective, and it identifies borrower quality via loan repayment. The basis of borrower quality is repayment ability. Loan performance is a necessary condition for being an acceptable borrower and if repayment ability were known with certainty, it would be sufficient. Although examiners use collateral value as indication of borrower quality, collateral value, which is not a necessary nor a sufficient condition for being an acceptable borrower, is only liquidated to recover outstanding principal and accrued interest if the loan cannot be repaid otherwise. Thus, for this study, the critical issue for determining borrower quality is loan performance and the dependent variable definition reflects this.

The weakness of this definition, as well as past ones, is that the definition does not distinguish well between the severity of default or the likelihood of the lender incurring a loan loss from a defaulted loan.

The second issue is the selection of an appropriate statistical procedure to estimate the classification model. The statistical method used in most past agricultural studies to classify farm borrowers by their loan default risk was multiple linear discriminant analysis (Reinsel and Brake; Bauer and Jordon; Johnson and Hagan; Dunn and Frey; Hardy and Weed). However,

linear discriminant analysis is acknowledged to be inappropriate when the explanatory variables are not normally distributed, which is typically the case with financial ratios (Ohlson). Probit and logit are statistical methods that have superseded linear discriminant analysis. With a binary dependent variable, the choice between probit and logit may be made arbitrarily because the empirical results will differ little except with very large samples (Maddala). For this study, logit analysis was chosen because of software support.

The third methodological issue is the effect a nonrandom sample has on an estimated logit model and how to compensate for it. Credit screening and loan review models require different samples. A credit screening model, used to discriminate between successful and unsuccessful loans, should be estimated from information on the initial loan application. Furthermore, both accepted and rejected applications should be included in the study (Joy and Tollefson). Only using the applications from existing borrowers would bias the results because a group of loan applicants—denied applicants—have been systematically rejected from the sample. A farmer denied a loan at one institution may have been credit worthy and may have become a good customer for another lender. On the other hand, the unsuccessful applicant may not have been credit worthy and may have become a problem for another lender. In either case, the information on unsuccessful applicants is lost when these potential borrowers are not included in the sample. Thus, the representation of the true population of loan applicants is distorted as a consequence of a sampling rule; the sample can no longer be considered random, and it is considered to have a type of selection bias (Heckman).

Loan review models are estimated with recent financial information from existing borrowers in the portfolio. Therefore, if a simple random sample of existing borrowers is used in the analysis, no statistical bias should be encountered. However, the proportion of problem borrowers is usually small in a healthy portfolio. Therefore, samples that include a disproportionately large number of problem borrowers are generally used to develop a credit assessment model. Those samples are usually stratified on the dependent variable, which makes them outcome-based samples. Manski and McFadden proved that an unweighted choice-based (outcome-based) sample will cause biased and inconsistent probability and parameter estimates in a logit or probit classification model.[1] Zmijewski showed that an unweighted outcome-based sample, which contains a disproportionately large number of financially distressed businesses, results in a probit model that overclassifies financially distressed firms and underclassifies nondistressed firms.

The sample used in this study is an outcome-based sample and must be weighted for the logit analysis to correct for bias. The weighting scheme selected to correct for bias was the weighted exogenous sample maximum likelihood method (Manski and Lerman). Thus, each borrower class is weighted by the ratio of its population proportion to its sample proportion.

The fourth issue is the method of reducing the number of financial measures that have been found significant in past studies, or are believed to influence borrower quality, to a manageable number of regressors for the final model. The list of potentially significant variables is frequently quite large because of the nature of ratio construction. Because no well-specified set of ratios has been found to explain financial performance, no well-defined method for selecting specific ratios as variables for a financial distress model is apparent (Marais et al.). Thus, prior studies have used data-analytic procedures to cull a subset of explanatory variables from a list of candidates (Marais et al.). However, overfitting to the data set is a problem with these data-analytic procedures (Marais et al.). Thus, it appears data-analytic methods are necessary, but flawed.

To select the data-analytic method for this

[1]In choice-based sampling, the classification of the population into subsets is based on the outcomes; for each outcome a random sample is drawn. This is an endogenous sampling process, as opposed to an exogenous stratification on the independent variables used as predictors (Cosslett).

analysis, ratio theory was relied on. Because empirical evidence exists that the means of financial ratios are significantly different between financially distressed and nondistressed businesses (Beaver), a method that analyzes differences between population means, analysis of variance (*ANOVA*), was used to select potential regressors.

The fifth methodological issue is the classification of the observations based on their estimated probabilities. The prior probability of being in a class and the misclassification costs can be used to select a cutoff point that optimally classifies the observations based on their estimated probabilities (Madala). If one assumes that the misclassification costs are equal, then the cutoff point is equal to the prior probability of being in a class (Martin). Because the costs of misclassification were not estimated and are assumed to be equal for type I and type II error, the cutoff point for the portfolio is equal to the prior probability of being an acceptable borrower.[2] For this analysis, the population proportion of being an acceptable borrower is 83.8 percent. Thus, an observation with an estimated probability of being an acceptable borrower that is greater than 83.8 percent would be classified as an acceptable borrower. A borrower with an estimated probability of less than 83.8 percent would be classified as problem borrower.

It could be argued that the assumption of equal misclassification costs negates the usefulness of the classification scheme for this analysis. However, because the borrowers most likely to be misclassified are borderline cases and the classification is only for the upcoming year, the costs of misclassifying a problem borrower as acceptable (type I error) or an acceptable borrower as a problem (type II error) may not be appreciably different. The misclassification cost most likely to be incurred with a type I error is increased servicing costs. With dynamic differential loan pricing, which is employed at the case bank, a misclassified problem borrower's interest rate can be raised at the time of default to compensate for the increased servicing required. Because this is a borderline existing borrower, he most likely would not cause a loss in that year. With type II error, a possible misclassification cost is lost revenue from the borrower refinancing with another lender. However, because the borrower is borderline, it is likely that a competitor would not offer a substantially lower interest rate due to differences in perceived default risk. Thus, the likelihood that a borrower would seek refinancing because of the risk premium charged is small and the misclassification cost most likely to be incurred is negative. Because this study is of existing borrowers and the classification is for the upcoming year, the misclassification costs are expected to be small and not appreciably different. With a credit screening model, the relevant misclassification costs would differ from this study's and the equal misclassification assumption may be inappropriate.

The last methodological consideration is the evaluation of the classification ability of a model. First, to correct for the problem of overfitting to a data set, an independent data set (a hold-out sample) should be used to validate results. A classification model should be tested with a hold-out sample to verify its classification rates and efficiency. In this study, a hold-out sample of thirty borrowers was selected randomly from the full sample to test the classification ability of models.

Second, the classification efficiency rates of a model should be compared with a benchmark rate. One such benchmark rate is the randomized naive model rate, which for a binary outcome, is 50 percent. Two other naive classification strategies are conceivable. They are (*a*) classify all observations as acceptable borrowers or (*b*) classify all observations as problem borrowers. With a loan review model, one would expect to do much better classifying everyone as acceptable than everyone as problems, or by classifying 50 percent as acceptable. The lending institution would surely soon go bankrupt if 50 percent of its loans were problems. Hence, as stated by Neter, the randomized strategy is a little too

[2]By convention, type I error is misclassifying a problem borrower as acceptable and type II error is misclassifying an acceptable borrower as a problem.

naive with an underlying proportion that is not near 50 percent.

A conditional probability model that accounts for prior probabilities is a more palatable benchmark rate (Neter). For example, if a 10 percent failure rate for an industry was known, then the conditional probability model rate for classifying business failure in that industry would be

$$[(.1 \times .1) + (.9 \times .9)] = 82 \text{ percent.}^3$$

In this case, a binary model that had a classification efficiency rate of less than 82 percent would be worse than the benchmark.[4]

None of the past agricultural studies compared their efficiency rates with the conditional probability efficiency rate. The following example shows the incomplete interpretation of a model's classification ability, which is based on the total correct classification rates. If the prior population proportion of acceptable borrowers for the past biclassification models had been at least 90 percent, then the benchmark model efficiency rate would have been 82 percent.[5] Using the proposed prior proportion rate of 90 percent, the efficiencies for the two previously reported biclassification models are $(.9 \times .9) + (.1 \times .6) = 87$ percent for Dunn and Frey and $(.9 \times .8) + (.1 \times .83) = 80$ percent for Weed and Hardy. The total correctly classified rates that were reported are 75 percent (Dunn and Frey) and 81 percent (Weed and Hardy). Thus, although total correct classification rates may appear quite good when compared with a 50 percent rate, they do not rate very highly when compared with an appropriate standard.

Empirical Application

Seven prior agricultural credit assessment studies have identified various financial and nonfinancial factors as being important in assessing borrower quality (Table 1). Yet, no financial measure has consistently been identified as significant. Financial measures that have frequently appeared in agricultural credit assessment models are: (*a*) a measure of solvency—significant in all but the first two analyses; (*b*) a measure of repayment ability—material in all but two analyses; and (*c*) a measure of liquidity or a ratio including short-term debts—important in five studies.

For this study, financial ratios of size, liquidity, solvency, profitability, capital efficiency, and operating efficiency were examined. A discussion of those measures follows. Business size measures describe the magnitude of resources a business controls. In the financial literature, it has been found that larger companies are less likely to fail (Ohlson). In agricultural research, farm size as measured by cow numbers was found to have either a positive effect or no influence on the success of dairy farms in New York state (Kauffman and Tauer). For this study, the measures of dollars of assets and cow numbers were included in the analysis.

Liquidity gauges the farm's ability to meet short-term obligations. In past empirical studies, farms with more liquidity have been found to be more likely to be acceptable borrowers (Table 1). For this study, the variables, debt payments per dollar of milk sales and debt per cow, were used in the analysis.

Solvency assesses a farmer's ability to pay obligations in the case of liquidation, or it can also indicate a firm's ability to withstand adverse conditions. Past agricultural studies have found that farmers with higher levels of equity were more likely to be acceptable borrowers (Table 1). For this study, percent equity was used to measure solvency.

Profitability gauges the net dollars of

[3]The conditional probability model assumes that observations can be classified at the same rate as their population proportion.

[4]To obtain the efficiency rate of a model for this example, the model's correct classification rate for failed businesses would be multiplied by 0.1 and that result would be added to the product of 0.9 and the model's correct classification rate for nonfailed businesses.

[5]An acceptable borrower population proportion (based on an examiner definition of an acceptable borrower that past studies used) of 90 percent does not seem out of line because in 1982 and 1983, the national proportion of acceptable borrowers was 88.4 percent and 87.0 percent respectively for PCAs (Irwin), and those years could not be considered ones of high borrower quality for PCAs.

Table 1. Factors Influencing Borrower Quality, Prior Agricultural Studies

Factor[a]	Study[b]								
	A	B	C	D	E	F	G	H	I
1. Farm Size	x						x		
2. Liquidity			x			x			x
3. Ratio of Short-Term to Total Debt	x	x			x				
4. Nonreal Estate Debt to Nonreal Estate Assets					x				
5. Solvency			x	x	x	x	x	x	x
6. Liabilities			x						
7. Collateral									x
8. Previous Increase in Net Worth	x	x							
9. Farm Ownership	x								
10. Number of Creditors	x								
11. Farming Experience	x								
12. Poor Production Records				x	x				
13. Repayment Ability		x				x			x
14. Note Amount to Cash Flow							x		
15. Loan Repayment to Assets								x	
16. Repayment History									x
17. Costs of Operation				x	x				
18. Living Expenses		x		x	x				
19. Reasonable Farm Value			x						
20. Expected Income as a Percent of Last Years				x					
21. Marital Status			x						
22. Life Insurance		x					x		
23. Health Insurance		x							

[a]Some like financial measures were grouped together, for example, solvency, liquidity, living expenses, repayment ability.

[b]A = Reinsel and Brake PCA; B = Reinsel and Brake FmHA; C = Bauer and Jordan; D = Evans PCA; E = Evans FmHA; F = Johnson and Hagan; G = Dunn and Frey; H = Hardy and Weed; I = Lufburrow, Barry, and Dixon.

income produced from investments. Logically, the more profitable a borrower, the less likely he or she will default on the loan. Researchers have found that an accrual measure of income better represents profitability than a cash measure (Lins et al.). Cash income ratios may only measure the farmer's ability to make debt payments in that year, but are less perfect measures of profitability because changes in inventories, accounts payable, and accounts receivable are not included. Since an accrual measure of farm income was not available, the proxy measures studied were cash earnings before interest and taxes (*EBIT*) divided by assets and *EBIT* divided by equity.

Capital efficiency ratios assess the farmer's ability to effectively use funds invested in the business. For this study, the value of assets per cow was included as a variable. Higher values of investment per cow generally represent lower capital efficiency and, thus, lower profitability for dairy farms in New York state (Smith and Putnam). Therefore, lower capital efficiency (a larger ratio) reduces the likelihood of timely payments.

The last group of factors incorporated into the study were those that measured operating efficiency. Those measures are: dollars of milk sold per cow (*DPPMS*), purchased feed cost per dollar of milk sales, operating expenses before interest divided by gross income (*CEBIPGI*), and young stock per cow. Typically, the more productive the farm or the more cost conscious the farmer, the more profitable the farm. Thus, the more likely the farmer is to make timely payments.

With the factors that may indicate borrower default risk identified, the borrower loan default model used for this study can be presented. Following Beaver's contention that with multiratio analysis each ratio

should convey as much additional information as possible, only one financial variable, which characterizes farm size, liquidity, solvency, profitability, or capital efficiency, is permitted in the logit model. More than one variable from the operating efficiency group is permitted in the model because those variables represent production as well as financial efficiency characteristics.

The Model Specification

The borrower loan default risk model for this study can be stated as follows:

The predicted probability of Y is

$$\hat{Y}_{i,t+1} = 1 - \frac{1}{1 + \exp\left[a + W_i \sum_{k=1}^{6} [b_k X_{k,t}]\right]}$$

The predicted logit of Y is

$$Y^*_{i,t+1} = a + W_i \sum_{k=1}^{6} [b_k X_{k,t}]$$

where for the ith observation

- $\hat{Y}_{i,t+1}$ is the predicted probability of being an acceptable borrower,
- $Y^*_{i,t+1}$ is the predicted log of the odds ratio of being an acceptable borrower,
- W_i is the weight (weighted exogenous sample maximum likelihood method),
- a is the intercept,
- b_{1-6} are the logistic regression coefficients,
- $X_{1,t}$ is a farm size measure from year$_t$ financial statements,
- $X_{2,t}$ is a liquidity measure from year$_t$ financial statements,
- $X_{3,t}$ is a solvency measure from year$_t$ financial statements,
- $X_{4,t}$ is a profitability measure from year$_t$ financial statements,
- $X_{5,t}$ is a capital efficiency measure from year$_t$ financial statements,
- $X_{6,t}$ are operating efficiency measures from year$_t$ financial statements.

The Data

The data for this project come from the short- and intermediate-term agricultural loan portfolio of a case study bank in upstate New York. From the sample frame, it was observed that larger lower-quality loans were few in number and that smaller performing loans were greatest in number. Because lower-quality and larger loans typically have a disproportionate effect on a portfolio's profitability and because a stratified nonproportionate stratified sample would be less costly than a simple random sample for the same level of accuracy, a general nonproportional stratified sample was taken.

The portfolio is stratified by loan size and loan quality. Large borrowers are defined as having a yearly average loan balance of $90,000 or greater during 1984, and small borrowers had less than a $90,000 balance. The $90,000 point was selected because the bank increased its analysis and requirements for any borrower who would have a loan balance of at least $100,000. The $90,000 point allowed for the effect of principal amortization throughout the year on the average loan balances.

Borrower loan contract compliance is used as the measure of loan quality. For this study, loan compliance is defined as paying the loan as scheduled without refinancing the loan. Borrowers who complied with the loan contract (made timely payments) are referred to as acceptable borrowers and those who did not as problem borrowers. Therefore, problem borrowers were in default of their loan contract at some time in 1984.

Using the aforementioned definitions of loan size and quality, which specify four borrower groups, a nonproportional sample of 203 borrowers was drawn from the portfolio. The sample consists of fifty-two large acceptable borrowers, twenty-four large problem borrowers, seventy-one small acceptable borrowers, and fifty-six small problem borrowers. The financial data were collected for all sample borrowers for the year 1983.

Initial Financial Variable Analysis

Because many ratios can be constructed to measure or represent farm size, liquidity, solvency, profitability, capital efficiency, and operating efficiency *ANOVA* is used to select the most important ratios that would be used in the logit models as explanatory variables. *ANOVA* is used to identify financial variables with significantly different means between the four borrower groups and to determine whether the group differences are due to loan size, loan quality, or the interaction of the two. The Statistical Analysis System (SAS) general linear models procedure is used to analyze the unbalanced two-way *ANOVA*.

Financial variables with means that are different only between borrower groups of unmatched loan sizes would not be considered of value for the logit analysis. Those variables would have similar values for high- and low-quality borrowers. Thus, the best financial measures would have overall *F* statistics that are significant and have significantly different means between loan quality groups. The *ANOVA F* statistics are reported in Table 2.

The results of the initial analysis indicate that only *DPPMS*, percent equity, *CEBIPGI*, and young stock per cow have significantly different means for the loan quality groups, but not the size groups. The measures debt per cow, value of equity, *EBIT* per dollar of assets, and milk sales per cow are significantly different between all groups. The variables value of assets, cow numbers, *EBIT* per dollar of equity, value of assets per cow, and purchased feed cost per dollar of milk sales are found to have either different means between borrower size groups or no apparent difference between all the groups. Thus, eight financial measures—*DPPMS*, percent equity, *CEBIPGI*, young stock per cow, debt per cow, value of

Table 2. ANOVA F Statistics for Financial Measures, 173 Borrowers, 1984

Factor	Overall	Loan Quality	Loan Size	Interaction
Farm Size				
Assets	28.12**	3.55	80.79**	0.04
Cows	25.11**	2.28	72.01**	1.03
Liquidity				
DPPMS[a]	10.20**	28.48**	0.42	1.70
Debt Per Cow	6.82**	9.75**	10.44**	0.28
Solvency				
% Equity	4.58**	10.19**	2.88	0.69
Equity	16.09**	9.32**	37.15**	1.81
Profitability				
EBIT/Assets[b]	6.59**	11.83**	5.31*	2.63
EBIT/Equity[c]	2.06	1.09	0.72	4.36*
Capital Efficiency				
Assets Per Cow	2.18	0.00	4.54*	2.02
Operating Efficiency				
PFCPMS[d]	2.85*	0.11	8.42**	0.02
CEBIPGI[e]	8.76**	21.81**	3.62	0.85
Milk Sales Per Cow	7.44**	13.96**	8.26**	0.10
Young Stock Per Cow	2.70*	7.09**	0.52	0.51

**Significant at the 1 percent level

*Significant at the 5 percent level

[a]Debt payments per dollar of milk sales.

[b]Earnings before interest and taxes per dollar of assets.

[c]Earnings before interest and taxes per dollar of equity.

[d]Purchased feed costs per dollar of milk sales.

[e]Cash expenses before interest and taxes per dollar of gross cash income.

equity, *EBIT* per dollar of assets, and milk sales per cow—are included in the logit probability analysis.

Logit Results

Using a sample net of the hold-out sample, loan default probability models were estimated to examine the relative importance of the eight financial measures in indicating potential borrower default. The hold-out sample was randomly selected from the full sample for use in verifying the classification ability of the models. Because the *ANOVA* results indicate that the larger and smaller borrower groups had significantly different levels for some ratios, the model estimation sample was partitioned and models were estimated for the large and small borrower groups.

Although the objective of the estimation was to find the best classifying model, two models, referred to as model one and model two, were found to be important for classifying borrowers as acceptable or problem. The only difference between model one and model two is that model one includes the variable, *EBIT* per dollar of assets, and model two replaces *EBIT* per dollar of assets with the variable, *CEBIPGI*. Thus the difference represents whether profitability or cost control is more important in determining the quality of borrower. The results of the estimated models for the portfolio are contained in Table 3. The variables that were found to indicate borrower loan quality are *EBIT* per dollar of assets, *CEBIPGI*, *DPPMS*, and young stock per cow.

The variables found to be unimportant in indicating borrower quality by the logit

Table 3. Loan Default Probability Model 1 and Model 2, 173 Borrowers, 1984

Variable	Coefficient	Chi Square	P Value
Model 1			
Intercept	1.335	1.70	.1920
EBIT/Assets[a]	11.199	4.25	.0393
DPPMS[b]	−4.503	8.82	.0030
Y. Stock/Cow[d]	1.319	1.69	.1936
Model 2			
Intercept	4.553	7.75	.0054
CEBIPGI[c]	−3.060	3.33	.0682
DPPMS	−3.670	4.86	.0275
Y. Stock/Cow[d]	1.489	2.11	.1467

Model Statistics		
	Model 1	*Model 2*
Chi Square with 3 D.F.	23.45	22.00
P Value	0.000	0.001
R	0.338	0.324
C Stat	0.764	0.763

Correct Classification Percentages		
	Model 1	*Model 2*
Estimating Sample		
Total	71.1%	68.8%
Acceptable Borrowers	73.1	71.1
Problem Borrowers	68.1	65.2
Classification Efficiency	72.3	70.1
Hold-out Sample		
Total	73.3%	73.3%
Acceptable Borrowers	94.7	84.2
Problem Borrowers	36.4	54.5
Classification Efficiency	85.3	79.4

[a]Earnings before interest and taxes per dollar of assets.

[b]Debt payments per dollar of milk sales.

[c]Cash expenses before interest and taxes per dollar of gross cash income.

[d]Young stock per cow.

analysis are percent equity, dollars of equity, milk sales per cow, and debt per cow. Those variables, when added to the portfolio models one and two, did not have parameters that were significantly different from zero at the 30 percent level of confidence. Thus, the variables did not increase the explanatory power of the models and were dropped to improve the efficiency of the estimates.

Model one (Table 3) contains financial measures representing profitability, liquidity, and operating efficiency. The independent variables are *EBIT* per dollar of assets, *DPPMS*, and young stock per cow, respectively. Model one has a chi square statistic of 23.45 with 3 degrees of freedom and is significant at the 0.01 level of confidence. The *R* for this model is 0.338, which is low, but not unreasonable for a logit classification model using individual farm observations.[6] Marais et al. concluded that small firms have worse statistical fits than large publicly traded firms in classification models due to inconsistencies in financial statements. Because the farms are small businesses, and the cash income statements and market value balance sheets that farmers use do not have the consistency that would be found with audited accrual statements, measurement error was expected. Thus, the lack of complete explanation of the log likelihood function was expected. The *C* statistic for this model is 0.764.[7] All the independent variables have the correct sign and are not highly correlated. *DPPMS* is significant at the 1 percent level and *EBIT* per dollar of assets is significant at the 5 percent level. The results imply that a higher-quality borrower has a lower *DPPMS*, a greater *EBIT* per dollar of assets, and a higher young stock per cow ratio. Therefore, a higher-quality borrower will be more liquid, more profitable, and have a higher operating efficiency.

Within the estimating sample, the model classified 71.1 percent of the borrowers correctly with 73.1 percent of the acceptable borrowers and 68.1 percent of the problem borrowers being correctly placed. Using the hold-out sample, the model classified 73.3 percent of the borrowers correctly with 94.7 percent of acceptable borrowers and 36.4 percent of problem borrowers being correctly classified. Under the assumption that borrowers can be classified at the same rate as the population proportion, the conditional probability model rate is 72.8 percent. By substituting in the model's correct rates, the efficiency of the model classifying borrowers with the estimating sample is 72.3 percent and with the hold-out sample it is 85.3 percent. Thus, this model performed as well as the conditional probability model with the estimating sample and better with the hold-out sample.

Model two (Table 3) contains two measures of operating efficiency and a measure of liquidity. The independent variables are *CEBIPGI*, young stock per cow, and *DPPMS*, respectively. Model two has a chi square statistic of 22 with 3 degrees of freedom and is significant at the 1 percent level of confidence. Model two has a lower chi square statistic than model one, but the chi square statistic is significant at the same level. The calculated *R* for the model is 0.324, which is slightly lower than the first estimated model. The *C* statistic for this model is 0.763, which is not substantially different from the first model.

With model two, the regressors have expected signs and are not highly correlated. *DPPMS* is significant at the 5 percent level and *CEBIPGI* is significant at the 10 percent level. For this model, a higher-quality borrower will have a lower *DPPMS*, a greater young stock per cow ratio, and a lower *CEBIPGI* ratio. Thus, a higher-quality borrower will be more liquid and operate more efficiently.

Within the estimating sample, this model

[6]The pseudo *R* for the model has a range of 0 to 1 and implies the amount that the model explains the log likelihood function (SAS).

[7]A statistic calculated by the LOGIST procedure is the classification, statistic, *C*. With a binary model, the *C* statistic is equivalent to the area under a receiver-operating characteristic curve (Hanley and McNeil). Thus, the statistic has a range of 0.5 to 1 with 0.5 indicating no apparent discriminatory power and 1 indicating perfect discriminatory power. In this study, the *C* statistic represents the probability that a randomly chosen acceptable borrower will be correctly rated with greater probability to comply with loan terms than a randomly chosen problem borrower.

classified 68.8 percent of the borrowers correctly with 71.1 percent of the acceptable borrowers and 65.2 percent of the problem borrowers being correctly placed. Using the hold-out sample, the model classified 73.3 percent of the borrowers correctly with 84.2 percent of acceptable borrowers and 54.5 percent of problem borrowers identified correctly. The efficiency of the model with the estimating sample is 70.1 percent, and with the hold-out sample it is 79.4 percent. Thus, this model did not perform as well with the estimating sample, but it performed better with the hold-out sample when compared with the conditional probability model.

To summarize, model two is equivalent to model one statistically, but model two is superior due to its ability to classify problem borrowers with the estimating sample. Thus, it appears that cost control may be a better determinant of borrower loan default probability than profitability for dairy farmers in this portfolio. Also, it appears that higher liquidity is desirable. However, neither model is greatly different from the conditional probability model with respect to classification ability. Because the models did not greatly improve the probability of correctly identifying acceptable and problem borrowers and due to the *ANOVA* results, which indicated borrower loan size groups had unique ratio levels, model one and model two were fit using data for the large and smaller borrower groups separately. This was designed to determine if separating the borrowers by loan size would improve the classification ability of the classification models.

Logit results for the large borrower group. Model one and two were fit using the data for the large borrowers only to examine whether the loan size range of the portfolio was too large for the ratios to be effective. The results of this estimation are presented in Table 4.

Model one fit to the large borrower group (Table 4), referred to as model one-large, has a chi square statistic of 14.23 with 3 degrees of freedom. Its chi square is lower than the population model's, but it is also significant at the 1 percent level of confidence. The *R* for model one-large is 0.336 and the *C* statistic is 0.758. Both are slightly lower than those for the full estimating sample. For model one-large, all the independent variables have the correct sign, but the value of the coefficients differ from the portfolio model. For model one-large, *DPPMS* is significant at the 1 percent level, but *EBIT* divided by assets and young stock per cow are nonsignificant at the 10 percent level.

For model one-large, 71 percent of the borrowers were correctly classified with 76.2 percent of the acceptable borrowers and 60 percent of the problem borrowers being correctly placed with the large borrower estimating sample. Using the large borrower hold-out sample, model one-large classified 71.4 percent of the borrowers correctly with 80 percent of acceptable borrowers and 50 percent of problem borrowers being correctly placed. The classification rates differ between the model one and model one-large, but not substantially.

To judge the classification ability of model one-large with the efficiency test, its conditional probability model rate is first calculated. For the large borrower group, a borrower has a prior probability of being an acceptable borrower of 72.5 percent, and thus the conditional probability model rate is 60.1 percent. The efficiency of model one-large with the estimating sample is 71.7 percent, and with the hold-out sample it is 71.8 percent. Thus, model one-large performed better than the conditional probability model with the large borrower estimating sample and with the large borrower hold-out sample. Compared with the portfolio model, model one-large classified worse by raw percentage, but did better when the gain in efficiency is considered.

The results of model two estimated for the large borrower group, referred to as model two-large, are presented in Table 4. Model two-large has a chi square statistic of 15.03 with 3 degrees of freedom. This statistic is lower than the population model's, but it is significant at the 1 percent level of confidence. The *R* for model two-large is 0.352, and the *C* statistic is 0.773. Both are slightly greater than the population model. All the independent variables have the

Table 4. Loan Default Probability Model 1-Large and Model 2-Large, 62 Borrowers, 1984

Variable	Coefficient	Chi Square	P Value
Model 1-Large			
Intercept	2.260	1.55	0.2129
EBIT/Assets[a]	12.007	0.94	0.3314
DPPMS[b]	−10.199	6.67	0.0098
Y. Stock/Cow[d]	1.528	1.58	0.2092
Model 2-Large			
Intercept	6.941	4.34	0.0372
CEBIPGI[c]	−4.517	1.67	0.1957
DPPMS	−8.720	4.42	0.0355
Y. Stock/Cow[d]	1.403	1.31	0.2528

Model Statistics

	Model 1-Large	*Model 2-Large*
Chi Square with 3 D.F.	14.23	15.03
P Value	0.003	0.002
R	0.336	0.352
C Stat	0.758	0.773

Correct Classification Percentages

	Model 1-Large	*Model 2-Large*
Estimating Sample		
Total	71.0%	75.8%
Acceptable Borrowers	76.2	78.6
Problem Borrowers	60.0	70.0
Classification Efficiency	71.7	76.2
Hold-out Sample		
Total	71.4%	85.7%
Acceptable Borrowers	80.0	80.0
Problem Borrowers	50.0	100.0
Classification Efficiency	71.8	85.5

[a]Earnings before interest and taxes per dollar of assets.

[b]Debt payments per dollar of milk sales.

[c]Cash expenses before interest and taxes per dollar of gross cash income.

[d]Young stock per cow.

correct sign, but the values of the coefficients differ from the results of the portfolio model. *DPPMS* is significant at the 5 percent level while *CEBIPGI* and young stock per cow are not significant.

Within the large borrower estimating sample, model two-large classified 75.8 percent of the borrowers correctly with 78.6 percent of the acceptable borrowers and 70 percent of the problem borrowers indicated correctly. Using the large borrower hold-out sample, model two-large classified 85.7 percent of the borrowers correctly with 80 percent of acceptable borrowers and 100 percent of the problem borrowers placed correctly. The classification rates are substantially greater for model two-large compared with model two. The efficiency of model two-large with the large borrower estimating sample is 76.2 percent, and with the large borrower hold-out sample, it is 85.5 percent. Thus, model two-large performed better than its conditional probability model. Compared with model two, model two-large has better total correct classification rates. Therefore, the unrespecified models appear to classify large borrowers at a higher efficiency rate than the portfolio models classify all borrowers.

In summary, it appears that the preferred model for this study is model two-large. Statistically, it is superior to the other three models, and it is also the best classifying model. Again, it appears that liquid dairy farmers who manage their costs well are

better quality borrowers. Also, cost control appears to be a better determinant of borrower quality than profitability.

Logit results for the small borrower group. As was noted before, models one and two were fit to the small borrower data; however, the results are disappointing. The results are not presented in this paper. Apparently, financial ratios based solely on farm financial records are not good determinants of borrower quality for the small borrowers. Because off-farm income was not available for this study, and it substantially affects a small borrower's ability to make timely payments, a possible explanation for the poor results with the smaller borrower group is that nonfarm information may be important in indicating small borrower loan quality.

Logit Results Comparisons

In assessing the relative classification ability of this study's preferred model, model two-large, it was compared with models in past studies. However, direct comparisons of this study's results to past agricultural borrower classification results do have limitations. First, this model is a loan review model. Second, the definition for acceptable and problem borrowers for this analysis is different from those of past agricultural studies. Third, past agricultural studies that used linear discriminant analysis likely violated statistical assumptions or did not offer proof that those assumptions were not violated. Fourth, the only agricultural loan study that used a method other than discriminant analysis failed to weight the outcome-based sample. Fifth, past studies did not evaluate or report the efficiency of their models. Thus, the interpretation of past results is difficult because of the inappropriateness of their procedures.

With the major differences between this and past studies recognized, an indirect comparison of the classification ability of this study's models is made. For this study's preferred model, which is model two-large, the total correct classification rate using the hold-out sample was 86 percent. Past studies had total correct classification rates of 79 percent (Lufburrow et al.); 75 percent (Dunn and Frey); 62 percent (Johnson and Hagan); 81 percent (Weed and Hardy); and 85 percent (Bauer and Jordan). It appears that model two-large is more effective in classifying acceptable and problem borrowers in its population than models developed in previous studies.

Conclusions

From the empirical analysis using logit models, financial measures of liquidity, profitability, and operating efficiency were found to indicate existing borrower quality in this sample. Furthermore, the logit models developed in this study classified borrowers better than a naive model and conditional probability model rate. The logit models appear to be effective and objective ways of classifying borrowers by default risk for use in a differential loan pricing program.

Several research areas need to be addressed in future agricultural credit assessment studies. How do different definitions of borrower quality affect the results of a credit assessment model? How to determine the characteristics of small borrowers that indicate borrower quality? Our study indicates that small borrowers and large borrowers can be unique. Thus future studies should consider identifying unique characteristics for large and small borrowers. Another area that needs attention is how to determine the cost of misclassifying a borrower or potential borrower. The costs of misclassifying a future problem borrower as acceptable or misclassifying an acceptable borrower as a problem are not truly known for agricultural borrowers. Until more is known about misclassification costs, researchers will not be able to minimize a misclassification cost function with a credit assessment model. Moreover, without this cost information, the expected savings or earnings from different classification models cannot be estimated.

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Farmer Mac: How Will It Affect Agricultural Lending?

Catharine M. Lemieux

Abstract

This study investigates the impact of a secondary mortgage market for agricultural real estate loans on agricultural lending using a disaggregated structural model of the U.S. economy. At a volume of 8 percent of farm real estate lending, this market has the potential to increase interest rates on Treasury and agency securities and to lower Federal Land Bank interest rates.

Depository institutions will experience a slight increase in market share, Farm Credit System market share will decline, and the market share for individuals and others will remain steady. Farmer Mac should accomplish its objective of increased credit availability for the farm sector.

Key words: secondary mortgage market, farm debt, simultaneous-equation model, agricultural interest rates.

With the passage of the Agricultural Credit Act of 1987 the Federal Agricultural Mortgage Corporation (FAMC) was born. This federal agency is patterned after the Federal Home Loan Mortgage Corporation (FHLC). Just as FHLC provides funding for savings and loan associations for residential housing loans, FAMC is designed to provide funding for agricultural real estate loans. This paper investigates the impact this new federal agency will have on the existing agricultural credit market.

Congress, faced with the financial crisis in agriculture, the increased failure rate of agricultural banks, and continued losses in the Farm Credit System (FCS), searched for ways to improve funding for agriculture. The secondary mortgage market for residential housing has been well received by the housing industry. In 1985, 52 percent of all new mortgages were backed by securities issued by the three federal agencies that make up the secondary mortgage market for housing (Tuchman). Research has shown that the secondary mortgage market increased the flow of funds to the mortgage market (Hendershott and Villani; Kaufman; Silber 1973; Seiders), stabilized the supply of credit (Hendershott and Villani; Kaufman; Silber 1973; Seiders), improved the marketability of mortgage contracts thus lowering risk premiums and reducing interest rates (Morrell and Saba; Grebler), increased housing starts (Hendershott and Villani; Silber 1973), and possibly caused disintermediation (Grebler; Kaufman). If those impacts are extrapolated to the farm sector one would expect a viable secondary market to increase and stabilize the flow of funds to the farm sector and lower risk premiums, thus lowering interest rates. A secondary mortgage market for agricultural real estate loans would increase the supply of funds available to banks for long-term agricultural loans. Farm

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mortgages are currently very heterogeneous with no standardization of rates, terms, or information collected making it difficult for investors to assess potential market risk. Standardizing loans to create loan pools will increase available information on borrowers. That should lower the uncertainty associated with long-term lending, reduce the risk premium attached to those agricultural investments, and increase the amount investors are willing to commit to the farm mortgage market.

Model Structure

To analyze the impact of a secondary market for farm mortgage loans on the farm sector, a comprehensive portfolio balance model of the U.S. financial sector was used. Disaggregation by asset, debt instrument, and sector allows the economy-wide impacts to be assessed. Financial assets are modeled using a portfolio theory approach. The choice between holding capital assets or financial assets depends on the expected rates of return and the degree of risk associated with each type of asset. Portfolio theory has the advantage of considering the effects of shocks to the economic system on the entire structure of interest rates rather than just across individual securities. As Roley pointed out, assets and liabilities must be jointly determined because asset (debt) stocks desired by one group of investors must adjust to new supplies of assets (debt) offered by other groups of investors. Penson pointed out the importance of including both income and wealth because some investors are constrained by wealth while others are constrained by income. The lagged dependent variable may be included under the partial adjustment hypothesis to estimate the length of the adjustment period between actual and desired stocks. Debt can be viewed as a negative financial asset and therefore can be modeled using the same theoretical approach described for financial assets. The structure of the demand for financial assets and debt is contained in Lemieux (1987).

Interest rates are hypothesized to be a function of the interaction between investor demands and the supply of financial assets. The supply of financial assets is influenced by fiscal and monetary policy actions. In this formulation, particular interest rates are a function of the aggregate demand for that security, interest rates on other assets and debt, and supply shifters. Examples of supply shifters are policy variables such as the discount rate and the ceiling interest rate on time deposits.

Investors' expectations are believed to be important determinants of interest rates (Mishkin; Backus et al.). A common proxy for expectations is the weighted average of past interest rates or the relevant variables used to forecast interest rates. A problem with this approach is that the inclusion of the lagged dependent variable in the demand equations not only implies a particular weighted average for past rates but also for all other independent variables. Additionally, Silber (1970) argued that because all interest rates tend to move together, it is probable that expectations tend to cancel each other.

Because of the general equilibrium nature of the model, changes in any particular interest rate are linked to all financial asset and liability markets as portfolio demand adjusts to shocks in the system. For example, changes in the interest rate on Treasury securities affect interest rates on demand deposits, agency bonds, and the interest rates on FCS debt. Changes in the prime lending rate, in turn, affect the rates on time deposits, and FCS debt. In this manner, the impact of fiscal and monetary policy is eventually transmitted to the farm sector.

This model consists of fifty-four endogenous equations, and it explicitly models the demand for Treasury securities, agency securities, demand deposits, and time deposits for each investor group. The investor groups include farm operator families (FOF); other domestic consumers (ODC); nonfarm businesses (NFB); foreigners; federal state and local government; depository institutions (DI); and other financial institutions (OFI). The change in outstanding debt is modeled for NFB, ODC, and FOF. Net household borrowing is disaggregated into real estate and nonreal estate borrowing and net NFB borrowing is estimated as an aggregate. Net farm borrowing is disaggregated into real estate and nonreal estate borrowing

provided by each of three agricultural lenders. DI (primarily banks and savings and loan associations), FCS (the Federal Land Bank and the Production Credit Associations), and individuals and others (life insurance companies, retirement funds, pension funds, individuals, merchants and dealers). Loan demand from Farmers Home Administration (FmHA), an agricultural lender whose activity is limited by congressional appropriations, is determined exogenously.

Estimation Results

The model was estimated in two blocks with two-stage least squares (2SLS) estimation using thirty-three annual observations (1952–84) for financial assets and fifteen annual observations (1970–84) for debt obtained from U.S. Department of Agriculture and Federal Reserve data. The shorter time period was selected because of the changes financial institutions have undergone in the last thirty years. Because the focus of this paper is on the impact of the new secondary agricultural mortgage market on existing agricultural lenders and interest rates in the economy, only selected equations are reported below. The full model is described by Lemieux (1988).

Interest Rate Equations

The presentation of five of the interest rate equations estimated follows. The numbers reported in parentheses are *t*-statistics.

$$\begin{aligned} RGB = {} & -1.244 + 0.020 \cdot DDMBFOR \\ & (-8.88) \quad (1.95) \\ & + 0.902 \cdot RGNMA, \\ & (22.27) \end{aligned} \tag{1}$$

The interest rate on long-term government securities (*RGB*) is positively related to the amount of the federal budget deficit that must be financed by domestic investors (*DDMBFOR*) and the interest rate on agency bonds (*RGNMA*). The equation indicates that there is a substitute relationship between agency and Treasury securities and the potential for crowding out.

$$\begin{aligned} RGNMA = {} & 1.955 - 0.012 \cdot ABTOT \\ & (17.00) \quad (-4.53) \\ & + 0.045 \cdot AGSEC \\ & (2.26) \\ & + 1.117 \cdot RGB \\ & (36.80) \\ & - 0.024 \cdot CODCRE, \\ & (-4.07) \end{aligned} \tag{2}$$

The interest rate on agency securities (*RGNMA*) is negatively related to investor demand (*ABTOT*) and positively related to the supply of agency securities (*AGSEC*). The positive sign on *RGB* substantiates the substitute relationship between agency bonds and Treasury securities. Increases in home mortgage credit by depository institutions (*CODCRE*) signal reduced demand for funds by federally sponsored credit agencies, thus lowering *RGNMA*.

$$\begin{aligned} RCL = {} & 1.833 - 0.011 \cdot DDT \\ & (4.28) \quad (-2.67) \\ & + 0.027 \cdot GSEC + 0.971 \cdot RD \\ & (1.62) \quad (5.47) \\ & + 1.873 \cdot D, \\ & (1.90) \end{aligned} \tag{3}$$

The prime interest rate (*RCL*) is negatively related to the quantity of debt demanded (*DDT*) and positively related to the Federal Reserve discount rate (*RD*) and the government deficit financed by domestic investors plus agency securities issued (*GSEC*). As the supply of those securities rises, the yield on agencies must rise to induce investors to hold the larger quantity. The higher agency rate forces other borrowers to pay a higher prime rate to compete for scarce investor funds. A dummy variable for the years 1981–84 was incorporated to account for structural changes in U.S. financial markets with the advent of the Deposit Institution Deregulation and Monetary Control Act of 1980.

$$\begin{aligned} RPCA = {} & 0.510 + 0.933 \cdot FICB \\ & (5.22) \quad (62.74) \\ & - 0.691 \cdot FICBAB, \\ & (13.22) \\ RFLB = {} & 0.214 + 1.316 \cdot RFLBB \\ & (0.85) \quad (19.07) \end{aligned} \tag{4}$$

$$\begin{array}{l} -\ 0.518 \cdot RCL \\ \quad (-7.91) \\ +\ 1.032 \cdot FLBAB_t \\ \quad (5.34) \end{array} \qquad (5)$$

FCS short- and long-term interest rates (*RPCA* and *RFLB*) are positively related to the interest rate on short- and long-term FCS bonds (*FICB* and *RFLBB*) and the risk premium on FCS bonds over other agency securities (*FICBAB* and *FLBAB*) and negatively related to the prime rate. The positive sign on FCS bond interest rates reflects the positive association between the cost of loanable funds to the system and the interest rate charged for loans. Due to the FCS practice of average cost pricing during much of the data period it is likely that FCS interest rates adjusted with lag to changes in other market rates. Also when comparing a short-term rate with a long-term rate the slope of the yield curve may change over time.

Farm Real Estate Debt

The following four equations estimate the change in total farm real estate debt and the change in long-term debt provided by three agricultural lenders.

$$\begin{array}{l} NSDTREF = -0.191 \\ \quad (-0.30) \\ \quad +\ 49.975 \cdot DVALREF \\ \quad \quad (5.69) \\ \quad +\ 0.192 \cdot FLBB_t \\ \quad \quad (1.66) \end{array} \qquad (6)$$

Net farm real estate borrowing (excluding FmHA borrowing) was positively related to the change in the value of farm real estate assets (*DVALREF*) and the outstanding quantity of Federal Land Bank Bonds (*FLBB*). *FLBB* was included to account for the relationship between increases in the supply of farm real estate funds and the total demand for those funds. The coefficient on *FLBB* indicates that a $1 billion increase in the supply of funds to the FCS increases net real estate borrowing $192 million.

$$\begin{array}{l} DFREDI = 0.155 - 0.121 \cdot RCL \\ \quad (0.68) \quad (-1.63) \\ \quad +\ 0.085 \cdot RFLB \\ \quad (2.34) \\ \quad +\ 0.008 \cdot NSDTREF \\ \quad (0.21) \\ \quad +\ 0.047 \cdot RTB \\ \quad (0.39) \\ \quad +\ 0.146 \cdot PCHFINC_t \\ \quad (1.35) \end{array} \qquad (7)$$

$$\begin{array}{l} DFREFLB = 0.523 - 0.178 \cdot RFLB \\ \quad (2.71) \quad (-4.47) \\ \quad +\ 0.161 \cdot RCL \\ \quad (5.16) \\ \quad +\ 0.350 \cdot NSDTREF_t \\ \quad (4.68) \end{array} \qquad (8)$$

$$\begin{array}{l} DFREIO = -0.625 + 0.657 \cdot NSDTREF \\ \quad (-3.52) \quad (9.56) \\ \quad -\ 0.070 \cdot RCL \\ \quad (-2.45) \\ \quad +\ 0.082 \cdot RFLB_t \\ \quad (2.25) \end{array} \qquad (9)$$

The change in farm real estate debt provided by each individual farm lender is positively related to the net change in farm real estate debt and negatively related to the interest rate on farm real estate debt. Net borrowing is positively related to the interest rate on alternative sources of credit. The interest rates on alternative investments are positively related to net real estate borrowing from DI because in an efficient capital market, farm borrowers must bid scarce funds away from alternative uses. The value of the percentage change in farm income is positively related to net long-term borrowing from *DI*, implying that increases in farm income increase net borrowing from depository institutions.

Farm Nonreal Estate Farm Debt

Estimation of farm nonreal estate debt equations follows the same pattern used for estimation of farm real estate equations. Equations estimating the net change in farm nonreal estate debt and net nonreal estate borrowing from three agricultural lenders are presented below.

$$\begin{array}{l} NSDTNREF = -1.458 \\ \quad (-1.64) \end{array}$$

$$+ 0.867 \cdot NSDTREF$$
$$(5.03)$$
$$- 0.440 \cdot RCL$$
$$(-3.57)$$
$$+ 0.520 \cdot FICB$$
$$(3.43)$$
$$+ 0.110 \cdot FINC, \quad (10)$$
$$(2.64)$$

The net change in total nonreal estate farm debt is positively related to the change in farm real estate debt, farm income, and the interest rate on FCS short-term bonds and negatively related to the prime interest rate. Farm expansions generally require additional equipment and operating capital so increases in nonreal estate debt generally follow increases in real estate debt. Increases in farm income increase the debt-carrying capacity of the sector. The interest rate on FCS short-term bonds is positively related to net nonreal estate borrowing largely because FCS loan rates are a function of the cost of funds to the system. The prime rate is the proxy for the interest rate charged by DI, the largest farm nonreal estate lender. Therefore, increases in the prime rate would decrease agricultural lending by DI, thus lowering overall nonreal estate farm debt.

$$DFNREDI = -1.437 - 0.154 \cdot RCL$$
$$(-4.97) \quad (-4.91)$$
$$+ 0.401 \cdot NSDTNREF$$
$$(8.91)$$
$$+ 0.060 \cdot FINC$$
$$(3.95)$$
$$+ 0.320 \cdot RGNMA$$
$$(9.46)$$
$$-0.422 \cdot PCHFINC, \quad (11)$$
$$(-2.91)$$

$$DFNREPCA = 1.366 - 0.103 \cdot RPCA$$
$$(2.20) \quad (-3.40)$$
$$+ 0.163 \cdot RCLPCA$$
$$(2.32)$$
$$+ 0.238 \cdot NSDTNREF$$
$$(3.58)$$
$$- 2.045 \cdot VALPAFOF, \quad (12)$$
$$(-1.54)$$

$$DFNREIO = -0.381 + 0.019 \cdot RCL$$
$$(-0.81) \quad (0.42)$$
$$+ 0.174 \cdot NSDTNREF$$
$$(3.86)$$
$$- 0.332 \cdot RPCA$$
$$(-3.30)$$
$$+ 0.265 \cdot ROL$$
$$(3.78)$$
$$+ 1.775 \cdot VALPAFOF.$$
$$(2.03) \quad (13)$$

Net short-term borrowing from each farm lender is negatively related to the short-term interest rate and positively related to the change in farm nonreal estate credit. Farm income is positively related to the change in nonreal estate debt from depository institutions and negatively related to the percentage change in farm income. This suggests that farmers are likely to repay short-term debt when income surges and to rollover or increase short-term borrowings to finance cash flow shortfalls. This is contrary to the findings for the change in long-term debt where farmers are more likely to increase long-term debt when income surges. As before, the interest rates on alternative investments are positively related to net short-term borrowing from DI. The spread between the prime rate and the interest rate on FCS debt is a significant determinant of the change in short-term borrowing from FCS. The value of physical assets is negatively related to the change in short-term borrowing from FCS indicating that demand declines as asset values increase while the opposite is true for individuals and others. It is possible that, as farmers increase their asset holdings, more of their short-term credit needs are supplied by merchants and dealers rather than the FCS. There is no interest rate series for individuals and others so the FCS short-term interest rate (*RPCA*) serves as a proxy. The positive sign on the prime rate and the FmHA interest rate indicate the FmHA and DI are substitutes for borrowing from individuals and others.

Model Validation

Estimating demand for a particular financial asset or liability by a particular investor

group provided accurate estimates of total demand as shown by model validation statistics reported in Table 1. Those statistics were based on in-sample forecasts from 1970–84. Errors in the estimation (as measured by the root mean square percentage error[1]) for the change in total farm debt were 3 percent. Errors in the estimation of total demand for various financial aggregates ranged from a low of 8 percent for total deposits to a high of 33 percent for Treasury bills and bonds. The root mean square errors[2] (RMSE) rather than the root mean square percentage errors (RMSPE) are reported for interest rates and difference variables because as the value on which the percentage error is calculated approaches 0 (as is the case for variables that have small values or frequently switch signs) the value of the *RMSPE* will be large regardless of the size of the error. The *RMSE* indicates that the interest rate equations predict actual interest rates fairly well.

The *U* statistics (Theil's inequality coefficients[3]) were all less than one, indicating that the forecasts were an improvement over the naive assumption that there would be no change between last period and this period. A value of 0 would indicate a perfect simulation. The *U* statistic for the change in nonfarm debt indicates that this equation has the smallest percentage deviation between actual and predicted values.

Time series data are often subject to autocorrelation problems. In an attempt to deal with that problem, Fair's procedure for

Table 1. Model Validation Statistics

Variable	Root Mean Square Error	U Statistic
	Farm Debt	
DSDTREF	0.71	0.54
DFREDI	0.45	0.76
DFREFLB	0.83	0.74
DFREIO	0.62	0.49
DSDTNREF	1.33	0.57
DFNREDI	1.25	0.53
DFNREPCA	0.48	0.67
DFNREIO	0.43	0.51
	Interest Rates	
RCL	0.99	0.29
RFLB	3.19	0.48
RPCA	1.68	0.33
RGB	2.34	0.40
RGNMA	2.09	0.38

estimation of simultaneous equation models with lagged endogenous variables and first-order serially correlated errors was run. The corrected coefficients were not vastly different from the reported coefficients. Only four sign changes occurred for the thirty-nine coefficients, and none of those were significant. In addition, the standard errors for the corrected equations were actually larger than the standard errors derived from the 2SLS estimates for all but five equations, indicating that the potential problem of underestimated variances as a result of autocorrelation was not severe.

Omitting relevant variables is the most commonly cited reason for the existence of autocorrelation. Estimation of a large structural model is an attempt to reduce the problem of omitted variables. Nevertheless, tests for autocorrelation often yield positive results because random factors tend to persist over several time periods, data collection procedures tend to impart serial correlation in many aggregated time series, and levels of variables today depend on the level those variables assumed in the past. The problem is that most correction procedures assume that rho, the coefficient of autocovariance, is a constant number over time. If that is true, accounting for autocorrelation will improve the accuracy of forecasts. The factors mentioned above are often not constant over time, especially in large samples. In this case, adjusting model coefficients for autocorrelation reduced the accuracy of the model predictions.

[1] $$\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\frac{\hat{Y}_t - Y_t}{Y_t}\right)^2}$$

[2] $$\sqrt{\frac{1}{T}\sum_{t=1}^{T}(\hat{Y}_t - Y_t)^2}$$

[3] $$\sqrt{\sum_{t=1}^{T}\frac{[(\hat{Y}_t - \hat{Y}_{t-1}) - (Y - Y_{t-1})]^2}{T}} \Big/ \sqrt{\frac{\sum_{t=1}^{T}(\hat{Y} - \hat{Y}_{t-1})^2}{T}} + \sqrt{\frac{\sum_{t=1}^{T}(Y - Y_{t-1})^2}{T}}$$

Policy Simulation Results

The simulation assumes a secondary mortgage market for agricultural real estate loans is operational and securities sales are equal to 8 percent of outstanding agricultural real estate debt minus FmHA real estate debt holdings for the last five years of the simulation period (approximately 8.5 billion in nominal dollars in 1984). That is equivalent to the level of activity authorized in the Agricultural Credit Act of 1987 for the third year of operation of the secondary mortgage market for agricultural real estate. The 1987 act places limitations on the amount of securities FAMC may issue for the first three years of operation. The first year securities, totaling not more than 2 percent of the total agricultural real estate debt outstanding at the close of the previous calendar year, less all FmHA real estate debt may be issued. The second year limitation is 4 percent and the third year limitation is 8 percent. Based on outstanding farm debt from 1982–84, the final three years of the estimation time period, the maximum market size for the third year of FAMC operations would be approximately $3.8 billion in real dollars. During this same time period the total agency security market was approximately $25 billion in real dollars implying that FAMC securities would represent a 15 percent increase in the size of the agency security market. The results of the simulation are reported in billions of real dollars so they can be adjusted for the size of market within a reasonable range.

Those securities would be mortgage pool securities as classified in the Federal Reserve Flow-of-Funds Accounts. In this model those securities are classified as FCS securities, which are a component of agency securities [*AGSEC*, equation (2)] and government securities [*GSEC*, equation (3)]. The quantity of FCS securities is a variable in the full model in the equation that estimates *RFLBB*, a variable in equation (5). Increases in agency securities are positively related to *RGNMA*, *RGB*, and *RCL*, and increases in the quantity of FCS mortgage securities issued increase *RFLB*. Changes in the interest rates affect interest rates on all financial assets and debt as investor holdings adjust to the changes in interest rates. The impact those securities have on FCS lending depends on the risk premium the public requires over other agency securities, the level of the prime rate, and the demand for FCS lending.

The impact of the secondary market for agricultural real estate loans is reported in Table 2. Each $1 billion of securities issued to back the secondary market increases *RGB* and *RGNMA* 13 and 16 basis points, respectively. *RCL* is relatively unaffected because in addition to being positively affected by the increase in agency securities it is negatively affected by the quantity of debt demanded by businesses and households. *RFLB* fell 16 basis points per billion dollars of securities issued.

Kaufman and Fair and Malkiel found that the relative amount of securities affects the yield differential between those securities. According to Kaufman's results, a $1 billion increase in Federal Home Loan Bank or Federal National Mortgage Association debt would increase agency rates 29 to 33 basis points, respectively, assuming no changes in Treasury debt or interest rates. Kaufman attributed that result to the endogenous

Table 2. Comparison of Simulation Result for the Base and FAMC Simulations[a]

Variables	FAMC	Base	Difference
Interest Rates			
RCL	4.32%	4.39%	−0.07%
RFLB	−2.60	−2.00	−0.60
RPCA	2.60	2.17	0.42
RGB	0.85	0.34	0.51
RGNMA	1.95	1.35	0.60
Farm Debt (Billions)			
DSDTREF	$2.25	$1.52	$0.73
DFREDI	−0.64	−0.62	−0.02
DFREFLB	2.47	2.12	0.35
DFREIO	0.34	−0.10	0.44
DSDTNREF	1.14	0.46	0.68
DFNREDI	−0.31	−0.78	0.47
DFNREPCA	0.43	0.40	0.03
DFNREIO	0.32	0.35	−0.02
Total Farm Debt	95.93	94.52	1.41
Financial Assets (Billions)			
Deposits	$1123.79	$1143.17	$ −19.38
Treasury Securities	167.47	152.89	14.59

[a]All values reported are deflated.

nature of the actions of those agencies. Mortgage assistance is most needed in tight credit markets so those agencies must borrow their funds when credit is scarce. Kaufman concluded that "induced agency financing leads to increases in interest rates during stringent credit periods when agencies are increasing the amount of their induced financing."

Total farm debt increased $1.4 billion with approximately 20 percent going to FCS, 32 percent going to depository institutions, and 30 percent going to individuals and others. The overall increase in farm debt represents a 1.5 percent increase in farm sector debt. Checking and time deposits declined approximately $5 billion for every one billion in securities issued. That amounts to a decline of 1.7 percent in total demand and time deposits. Investors as a whole shifted their portfolios away from deposits and into Treasury and agency securities. Treasury security holdings increased 10 percent with financial institutions accounting for most of the increase in holdings.

Conclusions

The agricultural credit policies contained in the Agricultural Credit Act of 1987 will have a significant impact on the economy as a whole. All agricultural lenders will benefit from those policies. Depository institutions will experience a slight increase in market share, FCS market share will decline, and the market share for individuals and others will remain steady. Farmer Mac should accomplish its major objective of increased credit availability for the farm sector. Those results agree with predictions made by Duncan and Harshbarger, Freshwater and Trechter, and Barkema et al.

Some disintermediation will take place as investors realign their portfolios in response to changing interest rates. Depository institutions will become increasingly dependent on federally sponsored credit agencies and the national credit markets as a source of loanable funds. Flexibility to endure economic downturns will be reduced due to increased leverage. Stringent and inflexible loan standards could accelerate the trend towards fewer, larger, farms if fewer applicants are able to qualify for assistance. However, if credit availability expands as this simulation predicts, it is possible that increased ease of entry into and exit from the farm sector will increase the number of interested buyers for agricultural real estate, thus strengthening agricultural land prices. Finally, increases in the interest rate on Treasury securities will increase the cost of financing the federal budget deficit. The cost to taxpayers will depend on the default rate on the underlying securitized loans but reserve requirements should minimize the government's exposure to risk. Administrative costs incurred by the Farm Credit Administration will be covered particularly through fees charged loan originators. Those results validate the initial predictions of the impact of the secondary mortgage market for agricultural real estate loans based on experience in the housing sector.

Although the impact on interest rates predicted in this simulation agree with results presented by Kaufman, it is likely that the results stated here tend to overstate the actual impact of issuing FAMC securities. Although FCS already has access to national credit markets, another agricultural security with a guarantee against default should open up an additional channel for the flow of funds into the agricultural sector, increasing the supply of agricultural credit. A final problem with these predictions, as with any econometric estimation, is the potential for structural change in the 1990s, particularly if this new financial institution becomes successful.

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Dairy Farm Size and Federal Income Tax Progressivity

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Abstract

The effects of farm size on the progressivity of taxes paid by full-time and part-time farmers is examined using a 1984 sample of Pennsylvania dairy farmer federal personal income tax returns. Under the Economic Tax Reform Act of 1981 we find, using tobit estimators of tax models, that the tax system yields larger farms a competitive cost advantage over smaller farms, negating the nominally progressive federal personal income tax rate structure. Simulations indicate that changes incorporated in the Tax Reform Act of 1986 restore modest tax progressivity. Implications of other popular tax reform proposals are simulated, including loss of cash accounting preference.

Key words: income taxes, farm size, dairy farm, tax reform, tax policy.

The economic impact of federal tax policies and tax reform proposals on the agricultural sector is of considerable interest. Is the federal personal income tax progressive in the agricultural sector, given tax preferences available? Does the income tax system generate significant tax advantages for larger family-operated farms, reducing their operating costs compared with smaller farming operations? We provide empirical insight into those and other issues by analyzing dairy farm size and income tax progressivity.

Under the Economic Tax Recovery Act of 1981 (ERTA) and earlier tax legislation, there was consensus that agricultural firms benefited from tax preferences that were not generally available to other individual taxpayers and nonagricultural firms. Some of the tax preferences that have been available in agricultural (and other) sectors have been lost or modified under the Tax Reform Act of 1986 (TRA of 1986). Preferential treatment of capital gains income and the investment tax credit has been lost under TRA of 1986. The earlier accelerated cost recovery system (ACRS) has been modified (MACRS) for depreciable assets placed in service after December 31, 1986. The post-TRA of 1986 depreciable asset recovery periods have been lengthened for most machinery, equipment, and structures to more closely approximate their economic lives.[1] One of the major tax

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[1]Depreciation is still accelerated, compared with the straight line method using useful economic life as the recovery period. Assets in the three-, five-, and seven-year classes under MACRS may be depreciated with the 200 percent declining balance method and switched to straight line depreciation when advantageous. Most agricultural equipment under TRA of 1986 moves to the longer seven-year recovery period. As one-half of the first year depreciation under MACRS may not be used until the end of the depreciation period, depreciation will often not be

preferences now limited to agricultural firms filing as individual farmer-taxpayers is the cash accounting provision (Schmidt and Garrison). There has also been serious discussion of eliminating tax preferences for cash accounting and the deductibility of business interest expense.

Using a microdata cross section sample of Pennsylvania dairy farmer federal tax returns for 1984 we focus on two major tax issues. Have federal tax policies, through allowable tax preferences, encouraged growth in farm size and encouraged participation in part-time farming? Tax rules usually influence economic behavior. Next, lacking data on behavioral adjustments to TRA of 1986 changes, we simulate the impact of those and other proposals on taxpayer-farmers before they had an opportunity to react. Knowledge of farmers' behavior under the rules of the earlier ERTA may provide useful insight into taxpayer-farmer behavior as tax rules change.

The paper is conventionally structured. First, earlier studies investigating the effect of the federal income tax system on farm size and investment are selectively reviewed. Second, the methodological framework and microdata set are discussed. Econometric estimates and analyses of the various tax issues constitute the third and major section. In the summary and implications of this investigation, our analyses of the data lead to several conclusions. The effective income tax rate structure was not progressive for tax-paying dairy farmers in 1984. Larger dairy farm operations with federal taxable income liabilities before tax credit had a competitive advantage over smaller operations with 1984 tax liabilities. We also attempt to interpret how some of our results might be influenced by TRA of 1986.

Previous Studies

The theoretical arguments concerning the impact that earlier federal tax codes have had on agriculture have been dealt with in some detail by Davenport et al. With regard to growth in farm size, their view was that the tax preferences, investment tax credits, and accelerated depreciation provided incentives for growth. They argued that it was plausible that the progressive tax rate structure of the federal personal income tax system was negated through the use of those provisions. However, they noted that this theory had yet to be fully tested. Our findings provide empirical support for those arguments.

Results of earlier studies on tax progressivity from the limited available applied work of which we are aware have been mixed. In a study of Indiana farmers reporting tax returns in 1978 and 1979, Baker and Lapp found that average tax rates did not increase with increases in farm size as measured by cash operating income. The progressive nature of the tax system was offset by the use of various investment tax credits. In a study of the U.S. agricultural sector using annual aggregate data, LeBlanc and Hrubovcak found that about 20 percent of net investment in agricultural equipment during the period 1956–78 could be attributed to tax policy. More recently, Peace and Sumner found no relationship between the creation of tax preferences for investment tax credits and accelerated depreciation on the timing of new plant and equipment investment over the period 1962–83. However, their results stem from tabular observations, not statistical analysis. Using Jorgenson's theoretical investment model, Carman and Hardesty link selected recent farm financial problems to decisions induced by past federal tax policy—policies often associated with tax preferences previously favorable to agriculture.

Methodology and Data Set

We investigate the effective progressivity of the federal personal income tax system with respect to size of dairy farms in Pennsylvania. If larger dairy farms pay a lower average tax rate than smaller farms due to tax preferences, then there would be a tax-induced incentive to increase farm size, assuming that larger operations generate greater economic profits.

Progressivity of the income tax system may be indirectly measured by the average tax rate. Average tax rates will rise as statutory

quite as rapid as under ACR with the shorter recovery period.

marginal tax rates progressively increase for higher levels of personal taxable income. Two measures of average tax rates for farmer-taxpayers are calculated and used as alternative dependent variables in regression models to investigate the relationship between tax rates and dairy farm size. The first is the ratio of the income tax liability to the adjusted gross income (AGI), which is the implicit average tax rate before tax credits (ATRBC). The second is the ratio of the net income tax liability after subtracting all individual tax credits to AGI, or the implicit average tax rate after credits (ATRAC). The ATRBC measure may be referred to as the *average nominal tax rate* and ATRAC as the *average effective tax rate*. AGI is used as a measure of income because it is the concept in tax law that is closest to what economists mean by total income (Pechman and Okner). In 1984 for the nation, AGI was 80 percent of personal income while taxable income was 68 percent of AGI (Pechman).

To investigate the dependent tax rate variables we needed two sets of explanatory variables. The first set, X, includes measures of farm size and sources of income and is the set in which we are primarily interested. The second set, Z, includes other exogenous variables that may affect tax rates (for example, the number of individual exemptions claimed and whether the taxpayer itemized deductions) that must be controlled as we study set X coefficients. The form of the regression model is

$$T = a_o + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + b_1Z_1 + b_2Z_2 + b_3Z_3 + u,$$

where

T = ATRBC or ATRAC,
X_1 = dairy farm size as measured by cash operating receipts and adjusted for changes in crop inventories,
X_2 = dairy farm size squared,
X_3 = dummy; 1 = working spouse deduction and 0 = otherwise,
X_4 = dummy; 1 = <50 percent of total net income from farming and 0 = otherwise,
X_5 = dummy; 1 = 50 to 80 percent of total net income from farming and 0 = otherwise,
Z_1 = dummy; 1 = itemized deductions, and 0 = otherwise,
Z_2 = number of personal exemptions claimed,
Z_3 = number of personal exemptions claimed squared,
u = normally distributed error vector with mean 0 and variance σ.

Several working hypotheses have influenced formulation of the regression models. The farm size variable should be positively associated with nominal ATRBC. AGI, taxable income, and thus the average tax rate, should rise with farm size as the statutory progressive federal personal marginal income tax rates increase, other things equal. The farm size squared variable should be negatively associated with ATRBC. ATRBC should rise as the proportion of income from nonfarm sources increases because that income should be relatively more difficult to shelter from the federal individual income tax. Off-farm income may be used either to subsidize farm operations or simply to augment farm income. In the first instance, other things equal, ATRBC will be lower than in the latter case. Alternatively, farm operations may be used to shelter (at least partially) off-farm income, leading to a lower ATRBC. Hence, expectations for the signs on the part-time farming and working spouse deduction variables are ambiguous. Given the nominally progressive structure of the federal individual income tax in 1984, it is reasonable to expect that the coefficients on farm size should be equal to or greater than zero after adjusting for business investment tax credits (ATRAC) for dairy farmers with net positive income tax liabilities after all adjustments, but the farm size coefficients should be smaller than when ATRBC is the dependent variable.

The microdata used are from 590 Pennsylvania dairy farmers filing tax returns in 1984. Those farmers are from a larger population of dairy farmers who participate in the Pennsylvania Farmers Association's financial and tax preparation record keeping service. The farms selected for study were limited to sole proprietorships that filed a federal individual income tax return in 1984

and had a taxable income of at least the zero bracket amount (ZBA) of $3,400. Dairy farmer-taxpayers having a taxable income of less than the ZBA were excluded because they had no federal income tax liability. To be classified as a farmer and included in the study, the farmer-taxpayer also had to report a minimum gross income on IRS Form 1040, Schedule F of at least $1,000. We assume that maximizing net-of-tax income is an important objective.

The two dependent variables, ATRBC and ATRAC, were calculated from the results of a tax-estimating model designed to reproduce all line entries on the IRS Form 1040 and all necessary accompanying forms and schedules. The tax model reproduced individual tax liabilities under the federal income tax rules applicable in 1984. To insure that the Form 1040 line entries were accurately reproduced, they were compared with actual Form 1040 line entries for a subsample of farmers and checked for consistency.

We also used the regression models to investigate the *preliminary* implications for farmer-taxpayers of four prominent individual income tax reform proposals: two enacted with TRA of 1986 and two seriously discussed but not enacted. The two new components of the tax rules are elimination of favorable tax treatment of realized capital gains of farm (and other) business assets and use of economic life for capital recovery, intended to be approximated with MACRS (Pechman, p. 188) rather than the shorter tax life of most depreciable assets under ACRS. We used the older pre-ETRA asset depreciation rules (ADR) for our simulations, which more closely approximated economic lives of depreciable assets than ACRS. Proposals seriously discussed but not incorporated into TRA of 1986 for the group of farmer-taxpayers we are analyzing are substitution of accrual accounting for cash accounting of income and expenses and elimination of the income deductibility of interest expense as a farm (or other) business expense in calculating taxable personal income. The tax model was modified for each alternative to account for the change indicated, allowing for a recalculation of the income tax liability and recomputation of the average tax rate, ATRBC[2]. Lacking data on behavioral adjustments to the four tax alternatives we simulate their impacts on dairy farmers *before* they had an opportunity to react by adjusting their behavior. That is, what will happen to dairy farmer ATRBC, assuming there is no change in machinery purchases or number of cull cows sold—an admittedly strict assumption? With this as a possible worst case scenario, it should be voided as dairy farmers change their tax management strategies as they become aware of the tax savings possible and reduce their ATRBC.

Estimation Results

Mean values of the variables used in the analysis are reported in Table 1. Average farm cash operating receipts after adjusting for changes in inventories were $114,662. Dairy farmer-taxpayers were classified according to the percentage of total net income reported coming from the farm operation (that is, Schedule F and the agricultural business parts of Form 4797 and Schedule D). Part-time, intermediate-time, and full-time dairy farmers are defined as those earning less than 50 percent, 50 to 80 percent, and more than 80 percent, respectively, of their total net incomes from farming operations. Two-hundred and five (35 percent) of the farmers were classified as part-time, 118 (20 percent) were defined as intermediate-time, and 267 (45 percent) were full-time operators. The mean average nominal tax rate before adjusting for tax credits (ATRBC) for all farms was 0.07. The variation in ATRBC across groups was small. After subtracting investment tax credits the effective average tax rate (ATRAC) for all farms was 0.028, or a 60

[2]Accrual accounting methods were substituted for cash accounting methods on Form 1040, Schedule F. This was achieved by accounting for inventory changes in crops and feed stored and production supplies, changes in accounts receivable and payable, and elimination of prepaid expenses. The change in capital gains tax was calculated by disallowing the 60 percent exclusion on the sale of farm business assets reported on Form 4797. Pre-1981 asset depreciation rules were used to recalculate annual depreciation on all farm business assets set up and reported under ACRS rules in the tax return data set. The former depreciation rules are more in line with the expected rates of economic depreciation than the latter. For the final proposal, interest payments recorded on Schedule F were disallowed as a tax deductible expense.

Table 1. Mean Values of Farm and Tax Characteristics, Pennsylvania Dairy Farm Taxpayers, 1984

Variable	Mean	Sample
Number of Tax-Paying Farmers		590
Farm Cash Operating Receipts Adjusted for Change in Inventories ($)	114,662	
Number of Taxpayers That Itemize Deductions		151
Number Personal Exemptions Claimed on Return		3.6
Number of Taxpayers Taking Working Spouse Deduction		187
Average Tax Rate Before Credits (ATRBC)*		
Part-Time Farmers	.074	
Intermediate-Time Farmers	.079	
Full-Time Farmers	.063	
All Farmers	.070	
Average Tax Rate After Credits (ATRAC)*		
Part-Time Farmers	.034	
Intermediate-Time Farmers	.035	
Full-Time Farmers	.021	
All Farmers	.028	
Number of Taxpayers with ATRAC = 0		353

*ATRBC is calculated by dividing the tax obligation as determined from Form 1040, Schedule XYZ by adjusted gross income. The calculation of ATRAC is similar except that all tax credits are subtracted from the numerator.

percent reduction from the average ATRBC. The full-time group had the lowest ATRAC at 0.021 while the intermediate-time group had the highest at 0.035. Sixty percent (353) of the dairy farmer-taxpayers were able to eliminate their tax liabilities after deducting investment tax credits; thus, their ATRAC was zero. That group simultaneously avoided paying federal personal income taxes in 1984 and reduced the real cost of assets purchased by the amount of the tax credit taken.

Parameter estimates of the regression models are reported in Table 2. The estimates reported in column one with ATRBC as the dependent variable and column two with ATRAC as the dependent variable are those for the tax system in place in 1984. In the first column the coefficient for the farm size variable is significant and has the positive sign expected. The positive sign indicates that an increase in farm size as measured by inventory-adjusted cash operating receipts is directly related to an increase in the nominal tax rate. The farm size-squared variable is not significant, but has the expected negative sign. The coefficients for nonfarm income, crudely reflected by the working spouse deduction variable and dummy variable for part-time farmers, are significant and have positive signs as expected. The dummy variable for intermediate-time farmers is significant at the 0.1 probability level with a positive sign, indicating that farmer-taxpayers in that category had higher ATRBCs than full-time farmers; part-time farmers had an even higher ATRBC. Curiously the itemized deduction variable is not significant. It is normally expected that personal income tax liabilities can be reduced when itemized deductions are taken, all things equal. Also as expected, the number of exemptions taken was significant with a negative sign—an increase in the number of exemptions claimed resulted in a decrease in the ATRBC.

The impact of tax credits is noted in the second column with ATRAC as the dependent variable. The coefficients on the farm size and size-squared variables are not significant. Those results imply that the tax system with tax credits was not progressive with respect to farm size. Dairy farmers with larger operations, as measured by cash operating receipts, were apparently able to offset a larger portion of their tax liabilities with business investment tax credits than those operating smaller farms. Thus the tax system, in effect, subsidized larger dairy farms with positive income tax liabilities before adjustments for investment tax credits, relatively more than smaller ones. The business investment tax credit lowers relative economic operating costs for the larger and presumably more efficient and profitable dairy farms.

There are two plausible explanations for the finding that operators of larger dairy farms pay effective average tax rates similar to those of smaller farmers. First, larger farms may be economically less viable than smaller farms, resulting in relatively smaller taxable incomes with respect to farm size.

Table 2. Estimated Tax Progressivity Before and After Tax Credits, Pennsylvania Dairy Farm Taxpayers

Independent Variables	1984 Tax Code		Accrual Accounting[b]	No Capital Gain Exclusion[b]	Pre-1981 Depreciation[b]	No Deduction of Interest Expense[b]
	ATRBC[a]	ATRAC[a]				
Intercept	0.070*	0.055*	0.066*	0.070*	0.080*	0.052*
	(5.90)	(6.02)	(4.85)	(5.93)	(7.55)	(4.59)
Farm Size ($)	2.6E-7*	8.6E-6	5.4E-7*	4.1E-7*	3.7E-7*	6.2E-7*
	(4.06)	(1.52)	(8.64)	(8.19)	(6.20)	(12.23)
Farm Size Squared ($)	1.9E-1	-1.6E-13	-4.5E-13*	-3.2E-13*	-2.2E-13**	-5.3E-13*
	(1.57)	(1.29)	(4.18)	(3.31)	(1.70)	(5.48)
Working Spouse Deduction	0.019*	0.016*	0.023*	0.014*	0.012*	0.019*
	(5.21)	(5.17)	(4.79)	(3.87)	(3.38)	(5.08)
Part-Time Dummy	0.010*	0.006	0.005	0.011*	0.009*	0.008**
	(2.54)	(1.62)	(0.88)	(2.79)	(2.08)	(1.83)
Intermediate-Time Dummy	0.008**	0.005	0.008	0.009*	0.011*	-0.002
	(1.66)	(1.24)	(1.42)	(2.05)	(2.16)	(0.66)
Itemizes Deduction	0.002	0.009*	-0.002	0.002	0.001	-0.010*
	(0.61)	(2.81)	(0.49)	(0.55)	(0.13)	(2.36)
Exemptions	-0.014*	-0.011*	-0.012*	-0.011*	-0.013*	-0.005
	(2.57)	(2.79)	(2.13)	(2.88)	(3.16)	(1.23)
Exemptions Squared	0.001	0.0005	0.0005	0.006	0.001	0.0001
	(1.19)	(0.97)	(0.88)	(0.75)	(1.25)	(0.23)
Regression Chi-Squared	125*	59*	161*	178*	174*	280*

[a]The dependent variable ATRBC is calculated by dividing the tax obligation as determined from Form 1040 Schedule XYZ, by adjusted gross income. The calculation of ATRAC is similar to ATRBC except that all tax credits are subtracted from the numerator.

[b]The dependent variable for models reported in columns 3-6 is ATRBC.

The t-statistic is in parenthesis. Single and double asterisks indicate significance at the 0.05 and 0.10 probability levels, respectively.

Second, larger farms may be more economically viable, but they were able to use investment tax credits to reduce tax liabilities from farm income and have enough remaining to offset or reduce tax liabilities from nonfarm sources sufficiently to end up with an effective average tax rate similar to that faced by smaller farms. The second reason is the more likely because a strong and direct relationship was found between farm size and taxable income in a preliminary analysis. The general conclusion is that larger dairy farms, relative to smaller dairy farms, have used farm business investment tax credits to reduce their tax liabilities on income from all sources.

Business investment tax credits were available for machinery and equipment purchases prior to elimination under TRA of 1986. Whether or not the tax system preferences have encouraged larger family farm operators to overinvest in those types of capital assets for tax management purposes cannot be directly determined from the type of analysis undertaken here. However, the tax implication of those kinds of investments is that effective average tax rates were reduced; the relative reduction for larger farms was greater than for smaller farms. This suggests farmer tax management strategies involving machinery and equipment purchases were more beneficial for larger profitable dairy farms, giving them a competitive cost advantage (see Carman and Hardesty) over profitable smaller dairy operators.

It is also of interest to note that both the part-time and intermediate-time farming dummy variables are not significant in the model when ATRAC is the dependent variable (column 2). This contrasts with the statistically significant results found for the same explanatory variables in the model with ATRBC as the dependent variable (column 1). The ATRAC results imply that after investment tax credits are subtracted from tax liabilities, part-time and intermediate-time dairy farmers do not pay a significantly different average effective tax rate than full-time dairy farmers. If income earned off-farm is more difficult to shelter from taxation relative to that earned on the farm, then it would be expected that farmers earning a larger share of their income off-farm would pay a higher average tax rate, other things being equal. The reported findings suggest that this did not

occur. Whether or not the tax system encouraged part-time and intermediate-time dairy farmers to undertake investments in machinery and equipment—items on which investment tax credit could be taken—in order to reduce their tax obligation cannot be determined from this analysis. However, the result is consistent with the assertion that those dairy farmers used investment tax credits to obtain effective average tax rates similar to those paid by full-time farmers.

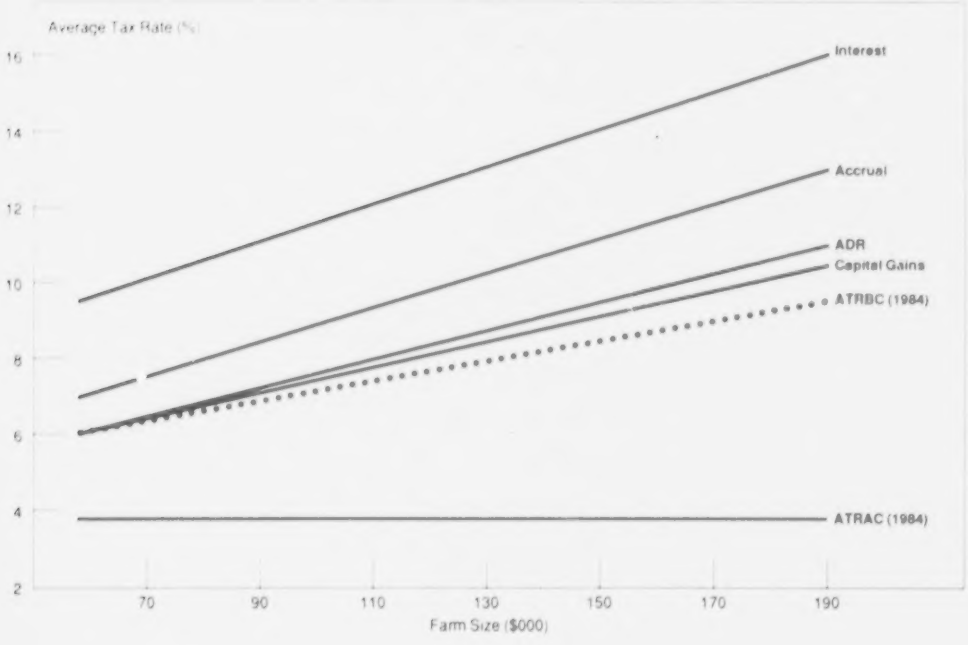
The ATRBC regression model was re-estimated with data adjusted by appropriately modifying IRS Form 1040 data for the four tax reform alternatives. The purpose of the analyses was to investigate the effects, individually, that tax reform provisions might have on the progressivity of the individual income tax with respect to size of farm, before dairy farmers behaviorally react to the changes to minimize their tax liabilities. The estimated results for the four alternatives are shown in columns 4 through 6 in Table 2. The regressions with *no capital gain exclusion* and *pre-1981 depreciation* approximate changes incorporated in TRA of 1986. The proposals to eliminate accrual accounting and the deductibility of business interest expense were not adopted; they are simulated in regressions in Table 2. In all four cases the farm size term is significant and positive; the estimated coefficients are larger than found for the farm size terms in the models using actual tax liabilities reported in 1984 (Table 2, column 1). Given decisions already made by dairy farmers, the ATRBC would have been considerably higher for farmers in the sample under each of the tax reform alternatives. The results indicate that average individual income tax rates (ATRBCs) were progressive with respect to size of farm and the rate of progressivity was greater than that found for the base case in 1984. The farm size-squared term has a negative sign as expected and is significant in three of the four cases. The estimated coefficients of the exemptions-claimed term are similar in magnitude, negative, and significant in three of the four cases. The variable measuring the extent of nonfarm income earned, the working spouse deduction, and the dummy variable for part-time farmers are also significant and positive.

In order to further compare the estimated results found for each of the four tax reform alternatives with the results found under the tax rules in place in 1984, an additional analysis was conducted. Using the parameters of the variables that were significant, ATRBC and ATRAC for the full-time farmers were simulated over a range of farm sizes for the six cases investigated. The values of the farm size variable used in the simulation ranged from adjusted farm cash operating receipts of $56,000 to $194,000 and were used with farm size-squared term. In each simulation the itemized deduction and working spouse deduction variables were assigned a value of one, and the number of personal exemptions-claimed variable was four. The values of the part-time and intermediate-time dummy variables were set at zero. The simulated results thus apply to a full-time dairy farmer-taxpayer who itemized deductions, took the working spouse deduction, and claimed four exemptions for the annual period 1984.

Graphs of the simulated results of tax reform on full-time dairy farmer ATRBCs by farm size, based on the tax system in place in 1984, are shown in Figure 1. The dotted line for ATRBC shows average tax rates before tax credits for the base 1984 tax system. Note that, given decisions made by farmers for the 1984 tax year, elimination of preferential treatment of realized capital gains would have resulted in a slightly more progressive tax system. ATRBC rises more rapidly if the tax reform is limited to loss of (or reduction in) accelerated depreciation. The shift from cash to accrual accounting as the only tax policy change leads to an even higher ATRBC. Full-time dairy farmer-taxpayers would apparently be most disadvantaged if they lost the income deductibility of interest expense.[3]

[3]The mean value for the ATRBCs was 7.46 percent for the 1984 baseline case of the tax system then in place. Considering the tax reform policies individually, (*a*) the mean simulated ATRBC rises to 7.95 percent when capital gains are treated as ordinary income, (*b*) returning to the ADR basis for depreciation raises the mean ATRBC to 8.14 percent, (*c*), shifting to accrual accounting raises the mean ATRBC to 9.63 and (*d*) loss of income deductibility of interest expense yields a mean ATRBC of 12.42 percent. The magnitude of the ATRBC and the progressivity of the individual income taxes with respect to farm size, as measured, would

Figure 1. Simulation of Average Individual Income Tax Rates for Several Policy Reform Options, for Full-Time Pennsylvania Dairy Farmers



Two conclusions emerge from analyzing the results. First, each of the tax reforms yields higher ATRBCs than the base 1984 case as farm size increases; the graph for each is above the ATRBC line, increasing the dairy farmers' tax liabilities before taking tax credits. Second, the larger the dairy farm measured, the greater the increase in pretax credit tax liability associated with each of the tax reform proposals, leading to greater tax progressivity by farm size.[4]

Returning to the 1984 base tax system analysis, the simulated result for the regression model with the ATRAC as the dependent variable is also shown in Figure 1. The ATRAC graph lies below the ATRBC graph and is horizontal. This indicates that, on average, dairy farms benefited from the business investment tax credit, but larger dairy farmers benefited more than smaller dairy farmers. The ATRAC graph's horizontal slope implies that larger dairy farmers paid an effective average tax rate similar to that of smaller dairy farmers. As well as benefiting more in the absence of

be significantly greater if the four tax reforms were simultaneously implemented, given decisions already made by taxpayer-farmers.

Assuming dairy farmers are influenced by taxes, they would have very strong incentives to reduce their interest expense if interest deductibility were lost. Coupled with the increased tax life of depreciable assets, there would be an incentive to replace equipment less frequently. Maintenance expenses that are deductible, for example, could be substituted for nondeductible interest expense to reduce tax liability and increase net after-tax real income.

While not reported here, the simulated results for the part-time and intermediate-time dairy farmers are similar to those shown in Figure 1 for full-time dairy farmers.

[4]The actual effects of tax changes adopted or proposed will be somewhat different because, on the basis of existing public finance theory, we expect each tax change implemented to alter dairy farmer behavior in a variety of operating areas. Our simulation results are derived by simulating the implications of the tax reforms adopted in TRA of 1986 or proposed, individually, given the 1984 decisions already made by taxpayer-dairy farmers. Thus our simulation results show the potential impact on dairy farmers, holding nominal tax rates and all decisions made in 1984 constant.

the four tax reform options reported above, larger dairy operations benefited relatively more from business investment tax credits.

The sample size of the dairy farms studied is large enough to partition taxpayer-farmers into three source-of-income groups for an additional analysis based on the percentage of total net income earned in the farm business. Regression equations were estimated for the part-time, intermediate-time, and full-time farmer-taxpayer groups, individually, to study the relationship between farm size and the tax rate variables ATRBC and ATRAC. The parameter estimates are reported in Table 3. For part-time dairy farmers deriving less than 50 percent of their total net income from the farm business, the farm size variable is not significant in the model when ATRBC was the dependent variable (column 1). However, the farm size-squared term is significant and positive, implying that for larger farm sizes the ATRBCs increased. Part-time taxpayer-farmers taking the working spouse deduction have a higher ATRBC than those not taking the deduction. When ATRAC was the dependent variable for the part-time group, the coefficient on the farm size variable is significant and negative, and the farm size-squared variable is significant and positive (Table 3, column 2). The results suggest that the tax system is regressive with respect to size of farm; the implication is that larger part-time dairy farmer-taxpayers used business investment tax credits to reduce their effective average tax rates, relative to the smaller scale operators.

For the intermediate-time group, the farm size coefficient is not significant in either model (Table 3, columns 3 and 4). However, the farm size term for the full-time group is significant and positive in the model with ATRBC as the dependent variable, but not significant when ATRAC was the dependent variable (Table 3, columns 4 and 5). The individual income tax system is weakly progressive with respect to size of farm for the full-time group when ATRBC was the dependent variable, but not progressive when the ATRAC was the dependent variable.

The general conclusion is that dairy farmers earning more than 50 percent of their total net income from the farm business apparently used the business investment tax credit to offset a larger fraction of their before-investment credit tax liabilities. Among dairy farms earning less than 50 percent of their total net income from the farm business, the larger-scale operators offset an amount of tax liabilities sufficient

Table 3. Estimated Tax Progressivity Before and After Tax Credits for Pennsylvania Dairy Farm Taxpayers by Percent of Total Net Income Coming from the Farm

Independent Variables	Part-time		Intermediate-time		Full-time	
	ATRBC[a]	ATRAC[a]	ATRBC	ATRAC	ATRBC	ATRAC
Intercept	0.121*	0.092*	0.075*	0.074*	0.060*	0.039*
	(4.41)	(3.85)	(2.45)	(3.39)	(3.56)	(2.90)
Farm Size ($)	-1.0E-7	-4.1E-6*	3.9E-7	-5.3E-8	3.1E-7*	-8.4E-8
	(0.71)	(3.09)	(1.44)	(0.31)	(3.12)	(1.02)
Farm Size Squared ($)	8.0E-13*	8.0E-13*	-5.4E-13	-4.4E-13	-2.3E-13	-4.4E-13
	(2.12)	(2.27)	(0.67)	(1.23)	(1.23)	(0.28)
Working Spouse Deduction	0.236*	0.028*	0.018*	0.007	0.141*	0.011*
	(3.74)	(4.89)	(1.94)	(0.91)	(2.47)	(2.39)
Itemized Deductions	-0.004	0.008	0.003	0.012	0.006	0.009*
	(0.54)	(1.11)	(0.34)	(1.35)	(1.19)	(2.12)
Exemptions	-0.025	-0.019	-0.016	-0.014	-0.013**	-0.005
	(1.48)	(1.39)	(1.05)	(1.62)	(1.84)	(0.79)
Exemptions Squared	0.002	0.001	0.001	0.0005	0.001	3.1E-5
	(0.87)	(0.60)	(0.39)	(0.54)	(1.02)	(0.04)
Regression Chi-Squared	36.2*	30.3*	25.2*	12.4*	68.3*	15.7*

[a]The dependent variable ATRBC is calculated by dividing the tax obligation from Form 1040, Schedule XYZ by adjusted gross income. The calculation of ATRAC is similar to ATRBC except that all tax credits are subtracted from the numerator.

The t-statistic is in parenthesis. Single and double asterisks indicate significance at the 0.05 and 0.10 probability levels, respectively.

enough to face effective tax rates lower than their smaller-scale counterparts.

Summary and Implications

The relationship between average nominal and effective federal income tax rates, farm size, and participation in part-time farming was studied for a selected sample of Pennsylvania dairy farmer-taxpayers that had a before-tax credit federal income tax obligation in 1984. A direct and significant relationship was found between the average nominal tax rate and dairy farm size as measured by adjusted farm cash operating receipts. However, after adjusting for investment tax credit to obtain the average effective tax rate, no significant relationship with farm size was found. Larger dairy farmer-taxpayers were able to reduce their federal income tax obligation to such an extent that they paid, on average, no higher effective tax rates than their smaller counterparts. The cross section analysis suggests that the tax system provided larger, and presumably more profitable, dairy farmers with tax incentives to invest and thus increase farm size. Given their behavior through 1984, larger dairy farmer-taxpayers were also found to benefit more than their smaller counterparts from the then allowable tax preferences—cash accounting methods, accelerated depreciation, favorable capital gains tax treatment on the sale of business assets, and the deductibility of interest payments on farm debt.

Even though nonfarm income is more difficult to shelter from taxation than farm income, part-time and intermediate-time dairy farmers were found to pay effective average tax rates similar to those paid by dairy farmers realizing more than 80 percent of their total net income from the farm business operation. Investment tax credit taken on purchased business machinery and equipment was an important tax provision used in sheltering income earned from nonfarm sources. Given business decisions made, the investment tax credit allowed 60 percent of farmer-taxpayers with taxable income to reduce their personal income tax liabilities to zero. Given that our sample was selected to exclude dairy farmers with less than the zero bracket amount of taxable income, substantially less than 40 percent of the dairy farmers participating in the Pennsylvania Farmers Association's financial and tax preparation records service paid federal personal income taxes in 1984, after all adjustments.

Tax rules in place in 1984 provided a competitive advantage to larger dairy farms and to dairy farmers earning a significant share of their total net income from nonfarm sources. Some of the tax preferences that contributed to this competitive advantage may have been lost under TRA of 1986. The provision for tax credits on purchased business assets and the 60 percent exclusion on capital gains income earned from the sale of business assets have been eliminated. Depreciation rules on business assets have been modified from ACR to MACR lengthening the depreciation period for most machinery, equipment, and structures, most likely resulting in relatively smaller annual depreciation write-offs. The cash accounting preference is still allowable for family farmer-taxpayers and interest expenses on farm business debt are deductible for all farmers. The impact that loss of some tax preferences will have on farmer-taxpayers with regard to incentives for growth in farm size and participation in part-time farming is not clear because tax rate schedules have changed. However, the loss of investment tax credit combined with the relatively slower rate of depreciation allowed and the taxing of capital gains as ordinary income will probably lead to a reduced rate of investment in new assets in dairy farming as average effective tax rates rise.[5]

It is not obvious whether the results found for the dairy operators studied will apply to other agricultural commodities. The family-operated farms studied are livestock farms that have annually had significant sales of cull cows that qualified for capital gains exclusion, a high proportion of capital investment in machinery and equipment on which an investment tax credit could have been taken, and produced a product that could not be easily stored or sold in a

[5]The expensing of capital has been increased from $5,000 to $10,000 and mainly benefits the smaller operations under TRA of 1986. Farming still generates tax shelters.

subsequent year for tax purposes. Other agricultural industries that contain a large number of family-operated farms have structural characteristics that differ significantly from those of the family dairy farm, and they employ different tax management practices.

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Calculation of Loan Losses: Restructuring Versus Foreclosure

David A. Lins and Lindon Robison

Abstract

The Farm Credit Act of 1987 requires the Farm Credit System (FCS) and Farmers Home Administration (FmHA) to restructure loans if loan losses are less than foreclosure. Procedures for selecting the appropriate discount rate, length of comparison, and cash flows to include in the analysis are presented. A case example is presented to illustrate the issues involved.

Key words: farm loan losses, farm loan restructuring, farm loan foreclosure.

The Farm Credit Act of 1987 mandates that the FCS and the FmHA restructure loans if that alternative is less costly than foreclosure. Of course, there are a variety of restructuring alternatives, and the least cost alternative is preferred. Losses from restructuring are typically measured as the difference between the current balance of principal and accrued interest compared with the net present value of cash flows arising from the terms of the restructured loan. Losses from foreclosure are defined as the difference between the current balance of principal and accrued interest compared with the net present value of cash inflows and outflows arising from the foreclosure action. Costs of foreclosure include not only legal fees but also holding and disposition costs of the assets that are acquired through foreclosure.

While the general procedure for estimating losses is clear, the specifics of how those calculations are made has generated controversy and uncertainty. One issue for example, is what discount rate is used to make the net present value calculations. A second is how cash flows are assessed for the restructured loan. There is also the issue of accounting for gains or losses in asset values that may occur between acquisition and disposal of property acquired through foreclosure. Another issue is how foreclosure-restructure decisions affect costs or returns for the remainder of the loan portfolio. An analysis and review of each issue follows.

Selecting the Discount Rate

Because the timing of cash inflows and outflows differs greatly between foreclosed and restructured loans, the discount rate selected for the analysis can have a significant bearing on the outcome. The consistency principle of net present value

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calculations (Robison and Burghardt) suggests that if cash flows are measured on an after-tax basis, then the discount rate should also be on an after-tax basis. A discussion of discount rates by lending institution follows.

Farm Credit System. In the context of the FCS, an example may clarify the issues. Suppose a Federal Land Bank (FLB) has a delinquent loan that is carrying a 12.5 percent interest rate, credit-worthy customers now pay 10 percent interest, the FLB's marginal cost of acquiring loanable funds is 8.5 percent, but the FLB's average cost of loanable funds is 10.5 percent. What is the appropriate discount rate?

In the case of foreclosure, the lender is considering liquidating an existing investment (a loan to a borrower). The appropriate discount rate can then be determined by asking: "What will we do with the funds generated by the liquidated assets?" If those funds will be used to retire bonds, the appropriate discount rate is the rate paid on the bonds retired, plus any overhead expenses eliminated. If the lender intends to use the funds to make new loans, the appropriate discount rate is the internal rate of return expected on the new loans.

In the case of a restructured loan, the appropriate discount rate is the opportunity cost, or: What will we do with funds generated if we liquidate this loan? Consequently it is clear that the discount rate for the restructured loan is based upon the same question as for a foreclosed loan. Thus, the discount rate for the two choices is comparable unless: (*a*) one uses risk-adjusted discount rates and (*b*) the risks of foreclosure and restructuring differ.

Based upon the above criteria, it is clear that the appropriate discount rate is *not* the interest rate on the existing loan. In our example, the lender is not able to place new loans at old interest rates. Second, there are servicing costs associated with the provision of loans and those servicing costs are recaptured through the interest charged. Consequently, the best alternative for money acquired through a foreclosure action should not be viewed as having the potential for generating a return equal to the interest rate, because that interest rate includes the cost of making and servicing a new loan.

A discount rate equal to the interest rate on new loans has also been suggested as an appropriate discount rate. Again, one can argue that the interest rate on new loans contains a fee to cover servicing costs and is therefore not appropriate. The counter argument is that loan servicing costs (salaries, accounting, billing, and so on) are fairly constant. In the short run this is likely true, but the FCS has cut operating costs substantially as loan volume has been reduced. The key is to be consistent. If the cash flows adjust for servicing fees, so should the discount rate or the IRRs from which we obtain the discount rate.

The *average* cost of loanable funds has also been suggested as an appropriate discount rate (St. Louis Farm Credit Banks). The rationale for this choice is that, at least in the past, the interest rates charged by the FCS have been tied to the average cost of funds rather than to the marginal cost. But if funds are recaptured through a foreclosure action, those funds will be used to pay off existing bonds or to finance new loans thus requiring issuance of fewer new bonds. To pay off existing bonds would require a repurchase in the secondary market at rates that reflect the current marginal cost of borrowing. Given this outcome, a discount rate based upon the expected marginal cost of loanable funds seems appropriate.

Farmers Home Administration. Regulations for the FmHA specify that "county supervisors will use a discount rate based on ninety-day Treasury Bills" (T-bills) when determining the net present value of payments for a restructured debt. This implies that the best opportunity for moneys obtained through a foreclosure process is to reduce the number of ninety-day T-bill issuances. But will money collected from FmHA foreclosure actions result in fewer T-bill issuances? To answer that question it is useful to trace the sources of funds used to support FmHA lending activities.

Funds for FmHA farmer programs are cycled through a revolving account, the Agricultural Credit Insurance Fund. The

primary sources of cash inflows for the fund are: (*a*) sales of certificates of beneficial ownership (CBOs) to the Federal Financing Bank, (*b*) principal and interest paid on loans, and (*c*) congressional appropriations. To the extent that funds acquired through foreclosure actions can be used to make additional FmHA loans, the use of a ninety-day T-bill rate may be inappropriate. In addition, when the Federal Financing Bank purchases CBOs, it does so at maturities suggested by the FmHA. Discussions with Federal Financing Bank personnel reveal that FmHA has had a tendency to issue fairly long maturity CBOs and consequently to pay rates that reflect the cost of issuing long-term government bonds. Therefore using a short-term rate as a discount rate for FmHA is not consistent with funding practices. A rate based upon maturities of CBOs appears to be more appropriate.

In a normal yield curve environment, short-term rates are lower than long-term rates. Consequently, the use of a ninety-day T-bill rate will likely understate the appropriate discount rate. Because the cash flows for restructuring alternatives are calculated over a much longer period of time than the cash flows arising from foreclosure actions, it will tend to generate a lower net present value of losses for restructuring alternatives than appears justifiable. In an inverted yield curve environment, the opposite effects would occur.

Case Example: Restructuring Versus Foreclosure

Let us assume the following facts for this case:

Principal amount owed to FLB	$303,624.20
Accrued interest	37,953.05
Amount of FLB stock	15,790.00
Interest rate on the FLB loan	12.50%
Remaining years to maturity	22
Scheduled annual amortization payments	$40,661.17
FLB marginal cost of capital	10%
Estimated amount of cash available to service FLB debt payments each year	$28,500.00

Restructuring Alternatives

1. Temporarily write down the interest rate to 7.35 percent. After year three, reinstate the original rate
2. Reamortize principal and accrued interest over thirty years and write down interest rate to 7.35 percent
3. Or, write down the principal amount to $221,342

Foreclosure Alternative	
Value of assets at foreclosure	$300,000.00
Annual inflation/deflation in land value	0%
Selling cost as a percent of value	5%

Restructuring of existing loans can take a variety of forms including: (*a*) extending the maturity, (*b*) temporary interest write-down, (*c*) temporary debt set-aside, (*d*) permanent principal or interest write-downs, and (*e*) combinations of the above. In addition, the FmHA and some other lenders have written shared appreciation mortgages as a condition for restructuring the loan. A discussion of key issues surrounding those alternatives follows.

Temporary interest or principal write-down. Under a temporary interest rate write-down, the rate on the existing loan is lowered, but only for a specified period of time. Under a temporary principal write-down (also called a debt set-aside), some portion of the principal either accrues no interest or defers the interest payment on that portion of the loan to some later date. Lenders have found temporary write-downs attractive because they offer the opportunity to minimize loan losses if the financial condition of the borrower improves.

In our case example, the interest rate reduction from 12.5 percent to 7.35 percent is only temporary. After three years the rate will again be set equal to the original 12.5 percent. Alternatively, one could *set aside* $120,235 of principal and accrued interest for three years and collect no interest on that amount.

In calculating the loan losses from a temporary write-down, a key issue is how to treat the loan once the temporary period has expired. If one assumes that the loan will return to full performance, then the losses associated with the temporary write-down are rather small. However, there may be a very high probability that the loan will not be returned to full performance and, thus, losses could be dramatically understated. Debt restructuring would thus appear much more attractive than foreclosure. One way to handle it is through a sensitivity analysis where the percent recovery of the loan after the temporary period of write-down is varied from 100 percent to 0 percent. Calculations of that nature are shown in Table 1.

Lender must determine how much of a recovery is needed before the temporary write-down becomes more attractive than other alternatives including foreclosure. Unfortunately, this is a subjective judgment, and it is not addressed by laws that mandate comparing loan losses from foreclosure with restructuring alternatives.

Permanent principal or interest write-down. As shown in our case example, the borrower can pay $28,500 per year in principal and interest. Accordingly, the lender should be indifferent between a permanent debt write-off and a permanent interest rate reduction so long as the total annual payments from the borrower are equal.

Lenders, however, are not indifferent between the two options. For one, a permanent principal write-down is somewhat more likely to be recorded on the lender's books as an operating loss in the current period. In contrast, the interest rate reduction is likely to affect future earnings and is therefore not recorded as a loss in the current period. (Note: Accounting procedures require current recognition of loss on a principal write-down only if the sum of the amortization payments is less than the current amount due.) Beyond accounting treatment of losses, there are other reasons why the lender is less likely to be indifferent between the two alternatives.

Table 2 shows the net present value of loan losses for the restructuring alternative assuming the write-down of principal or interest is permanent. The actual amount of loan losses is calculated based upon the year in which the loan is paid off. As expected, the present value of loan losses for the permanent principal or interest write-down is identical if the loan remains intact for thirty years. However, if the loan is paid off early, the interest write-down

Table 1. Loan Losses From a Temporary Write-down Principal or Interest

Original Loan Amount Including Accrued Interest, $341,577

Cash Flows by Year	*Payment*	*Loan Balance*	*Discount Rate*	*Present Value*
Year 1	$28,500	$338,183	.90909	$25,909
Year 2	28,500	334,539	.82645	23,554
Year 3	28,500	330,628	.75131	21,412
				$70,875

Loan Recovery at End of Temporary Write-down

Percent Recovery	*Amount Recovered*	*Present Value*	*Loan Loss*
100%	$330,628	$248,405	$ 22,299
90	297,565	226,564	44,130
80	264,502	198,723	71,979
70	231,440	173,883	96,819
60	198,377	149,043	121,659
50	165,314	124,202	146,500
40	132,251	99,361	171,341
30	99,188	74,521	196,181
20	66,126	49,681	221,021
10	33,063	24,841	245,861
0	0	0	270,702

Table 2. Loan Losses for Principal Write-down Versus Interest Rate Reduction

End of Year	Scheduled Payment	Principal Balance		NPV of Loan Loss if Loan Paid off at Year End	
		Interest Write-down	Principal Write-down	Interest Write-down[1]	Principal Write-down
0		$341,577	$221,342		
1	28,500	338,183	220,510	8,229	115,205
2	28,500	334,538	219,573	15,635	110,648
3	28,500	330,627	218,520	22,299	106,526
4	28,500	326,427	217,335	28,283	102,794
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.	.	.	.	.	.
29	28,500	26,549	25,333	72,869	72,946
30	28,500	0	0	72,910	72,910

[1]Calculated as the current principal plus accrued interest less the discounted value of scheduled payments and the discounted value of the principal balance.

generates a smaller loss than the principal write-down.

In our case example above, suppose that after three years under the restructured loan the farmer quits farming and pays off the loan balance. Under the permanent debt write-off, the lender's actual losses are found by taking the net present value of the three annual payments plus the net present value of principal amount paid off at the end of year three. The calculations are as follows:

Time	Amount	Discount Factor	NPV
1	$ 28,500	.90909	$ 25,909
2	28,500	.82645	23,554
3	28,500	.75131	21,412
3	218,520	.75131	164,176
		TOTAL	$235,051

Under that situation loan losses are $106,526 (341,517 - 235,051) or much higher than the $72,910 if the restructured loan continues performing for thirty years. Notice that because the interest rate on the loan is greater than the lender's discount rate, the loan losses increase if the loan is paid off early.

For the permanent interest rate write-down, losses decline if the restructured loan is paid off early. For example if the farmer in our example paid off the loan at the end of three years, the net present value of cash flows would be:

Time	Amount	Discount Factor	NPV
1	$ 28,500	.90909	$ 25,909
2	28,500	.82645	23,554
3	28,500	.75131	21,412
3	330,627	.75131	248,403
		TOTAL	$319,278

Loan losses under this scenario are only $22,299 (341,677 - 319,278), or much less than if the loan stays on the books for thirty years. Notice now that when the interest rate on the loan is less than the discount rate, loan losses are less if the loan is paid off early.

In practice, lenders have often found it necessary to lower interest rates well below current market rates to achieve cash flow feasibility. Consequently, loans with a permanent interest rate write-down are less likely to be paid off early than loans with a permanent debt write-off.

Given those outcomes, it is easy to see that the loan losses associated with permanent principal or interest write-downs depend critically upon actions taken by the borrower after the restructuring is accomplished. Lenders will likely prefer an interest rate write-down because their losses will be less than a principal write-down if the loan is paid off any time prior to maturity.

When loan losses under restructuring are

compared with foreclosure, what assumptions should be made about the payoff period of the restructured loan? Historic performance of loan payoff periods might serve as a useful guide. On the other hand the entire loan portfolio of a lender may not be the relevant group for determining payoff periods. For example, it may be that the most successful and the most unsuccessful borrowers have the highest probability of paying off their loans early—the first from profits, the second from liquidation proceeds. The point is that due to early loan payoffs, estimated loan losses incurred from restructured loans are not likely to be very accurate if calculated by discounting scheduled cash flows over the entire life of the restructured loan or if the loan rate and discount rate are not identical.

Foreclosure alternative. Cash flows occurring under restructure alternatives are fairly easy to define and measure. In contrast, cash flows for the foreclosure alternative are more uncertain. Cash outflows include expenditures for legal costs and administrative expenses. Cash inflows include rental income from the property, recapture of borrower stock, the net sale price of the foreclosed property, and a deficiency judgment if any. Estimates of those cash flows for a typical foreclosure are shown in Table 3.

Table 3 shows the net present value of loan losses for the foreclosure using a discount rate of 10 percent. Comparing Table 2 with Table 3, we can see that the restructuring alternatives are less costly than foreclosure. Under current legislation, the FCS would then be required to restructure rather than foreclose. However, if the loan restructure involved a principal write-down, the amount of the actual loan loss could be much higher than foreclosure if the restructured loan is paid off before maturity. Notice also from Table 1 that if less than 80 percent of the value of the loan could be recovered after a temporary write-down, the foreclosure alternative would be less costly. If recovery is 80 percent or higher, the temporary write-down is less costly.

Changes in asset values. When a lender acquires assets through a foreclosure action, there is a holding period before those assets can be disposed of or resold. For example, some lenders are experiencing holding periods of two to three years on farm real estate acquired through foreclosure. To the extent that such assets increase in value during the holding period, the cost of foreclosure is reduced. And to the extent that such asset values decrease in value during the holding period, the cost of foreclosure is increased. Thus a critical component of comparing the cost of foreclosure with the cost of restructuring the loan is the increase or decrease assumed in assets during the holding period. In our case example, the foreclosure alternative would be less costly than the restructure alternative if land inflated at 4 percent or more per year from the time of acquisition by foreclosure to disposition.

For lenders that write shared appreciation mortgages as a part of the restructuring package, the issue of asset appreciation is also important. If the lender expects to obtain funds under that provision, losses

Table 3. Net Present Value of Cash Flows for the Loan Foreclosure Alternative

	Year			
Cash Flows	**0**	**1**	**2**	**3**
Legal Cost	−1,300	−1,300	−1,300	0
Administrative Costs	0	−3,000	−3,000	−3,000
Rental Income	0	+12,000	+12,000	+12,000
Stock Recapture	+15,790	0	0	0
Net Sale Proceeds	0	0	0	+285,000
Deficiency Judgment	0	0	0	0
Net Cash Flow	14,490	7,700	7,700	294,000
Discounted Cash Flow at 10%	14,490	7,000	6,364	220,885
Accrued Principal and Interest	341,577			
NPV of Cash Flows	248,739			
NPV of Loan Losses	$ 92,838			

associated with restructuring are less than they might otherwise be. But how should future changes in asset values be determined?

The 1987 Farm Credit Act and subsequent rules do not address those issues. Consequently, one should expect the courts to rule in favor of procedures that are consistent with experts' opinions on future directions for asset values. For example, a recent survey by the Federal Reserve Bank of Chicago revealed that people knowledgeable about the land market in the Corn Belt expect land values to increase. On the basis of those expectations, the cost of foreclosure is reduced because of increasing asset values. FmHA has set up state advisory committees to help determine the expected change in asset values.

Portfolio effects. The decision to restructure or to foreclose on an individual loan is likely to have impacts on the remainder of the loan portfolio (Boehlje et al.). For example, foreclosure actions may send a signal to other delinquent borrowers that the lender takes such delinquencies seriously. That could result in better payment efforts on the part of other borrowers. However, an aggressive foreclosure policy could create a negative image thereby creating an early paydown of performing loans or possibly driving away potential customers. Bad press could increase the pressure on lenders to not foreclose on other borrowers.

Restructuring of individual loans can also affect the remainder of the loan portfolio. For example, some borrowers who are current on their loan payments have reacted quite negatively to lenders who have offered lower interest rates to problem borrowers as a part of a restructuring package. Likewise, a liberal policy on restructuring could lead to intentional delinquencies with the expressed purpose of getting a better deal through a restructured loan.

How should portfolio effects be evaluated when comparing loan losses for debt restructuring with foreclosure? The legislation does not address the issue. However, a study of the debt restructuring activities of the Farm Credit Banks of St. Paul (Boehlje et al.) revealed significant portfolio effects. Allocating those portfolio effects to individual loans, however, would be a costly and imprecise exercise at best.

In Summary

The 1987 Farm Credit Act mandates that the FCS System and FmHA restructure loans if that is a less costly alternative to foreclosure. Assumptions concerning the length of payoff for the restructured loan, the discount rate used, and increases or decreases in asset values are all critical.

Because the outcomes will vary widely depending upon the assumptions made, one can likely expect court cases challenging the set of assumptions used. Expert witnesses will likely be asked to provide their best insights as to the reasonableness of the assumptions underlying the calculations.

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Geographical Lending Diversification: An Analysis of Regional Agricultural Asset Returns and Risk

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Abstract

Adjusted per acre net incomes for the forty-eight contiguous states were used to analyze geographic considerations related to the secondary farm mortgage market and potential mergers of Farm Credit System (FCS) districts. A portfolio model was solved to determine expected return-variance (EV) efficient frontiers for state groups and FCS districts. Unconstrained EV frontiers were more risk efficient than partially restrained portfolios based on existing debt levels. In addition it was found that risk reductions can be obtained by considering correlations of agricultural returns when merging FCS districts.

Key words: diversification, Farm Credit System, portfolio analysis, risk, secondary market.

To facilitate the development of a secondary market for farm real estate loans the Agricultural Credit Act of 1987 contained a provision that created the Federal Agricultural Mortgage Corporation (FAMC). Under the terms of the provision, the FAMC will underwrite farm real estate loan pools, thereby guaranteeing timely principal and interest payments to pool investors. Pools will consist of farm real estate loans backed by first liens on properties having loan-to-value ratios less than 0.8. Loans cannot exceed $2.5 million and the real estate backing the loan cannot exceed one thousand acres. Borrowers cannot have more than one loan in a pool and must be engaged in agricultural production on the mortgaged properties. Pools must consist of at least fifty loans from geographically dispersed areas representing different types of agriculture.

The success of the secondary farm mortgage market depends on many factors. Three of the more important are: (*a*) credit quality, the credit quality of pools must be assured by having sound loan and pool underwriting criteria; (*b*) volume, a significant volume of pools must exist so that the secondary market's liquidity is assured; and (*c*) information, issuers of pool securities and investors must have adequate information to accurately price loan pools (Oliva). Meeting the credit quality condition will be aided by efficiently combining loans from geographically dispersed areas into expected return-risk efficient sets.

The primary purpose of this article is to analyze geographic combinations of loans that result in EV efficient sets. Combining geographically dispersed loans is known to

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reduce lending risks (Barry and Barnard), and it has been suggested as one means for insuring a sound agricultural lending system (Harl). In addition, loans from geographically dispersed areas likely will result in loans from differing types of agriculture, one requirement set forth for the secondary farm mortgage market in the Agricultural Credit Act of 1987. While the possibility of risk reduction is known, optimal compositions of loan pools are not known. Identifying EV efficient sets will aid in achieving the credit quality condition. Furthermore, knowledge of efficient sets should be of value to investors and issuers, thus aiding in meeting the information condition.

A secondary purpose of this article is to examine risk reduction possibilities resulting from combining FCS districts. The Agricultural Credit Act of 1987 requires that the FCS consider district mergers. One consideration in proposed merger activities is correlations of agricultural returns between districts. Making use of less than perfect correlations can reduce risks associated with agricultural lending.

The remainder of this article is divided into four sections. The first three deal with EV sets from geographical combinations of agricultural loans and describe methodology, data, and results. The fourth section examines potential FCS mergers.

Methodology

Mean-variance portfolio theory provides a framework for determining expected return-risk efficient sets preferred by risk-averse individuals. Portfolio theory has weaknesses and criticisms, mainly revolving around assumptions concerning utility, perfect markets, and characterizations of distributions (see Anderson et al.; Levy and Markowitz; Kroll et al.; and Meyer for discussions pertaining to violations of the normality assumption). Despite known limitations, portfolio analysis is a popular methodology for analyzing agricultural risks due to its solid underpinnings in financial theory, and because violations of normality assumptions, in many cases, do not seem to bias results. It is used here to derive EV sets.

To derive the efficient frontier, quadratic programming is used to minimize portfolio variance for differing levels of return

$$\text{Minimize } \sigma^2_p = \sum_{i=1}^{n} x^2_i \sigma^2_i + \sum_{j=1}^{n} \sum_{k=1}^{n} x_j x_k \sigma_{jk} \quad \text{for } j \text{ not equal to } k \qquad (1)$$

Subject to

$$\sum_{i=1}^{n} x_i = 1, \qquad (2)$$

$$\sum_{i=1}^{n} x_i r_i \geq r_p, \qquad (3)$$

$$x_i >= 0, \; i = 1, \ldots, n, \qquad (4)$$

$$p_l <= x_i <= p_u, \; i = 1, \ldots, n, \qquad (5)$$

where σ^2_p equals the portfolio variance; n is the number of assets; x_i equals the percentage of total dollars in the portfolio invested in asset i; σ^2_i is the variance of the ith asset; σ_{jk} is the covariance between assets j and k; r_i equals the expected return on the ith asset; r_p is the expected return on the portfolio; p_l is a lower limit on the percentage that asset i composes of the portfolio, and p_u is an upper limit on the percentage that asset i composes of the portfolio.

Equation (2) assures that the percentages of the portfolio invested in all of the securities add up to one. The third equation states that the expected return of the portfolio is a weighted sum of the expected returns of the investments, which must at least equal r_p. The efficient EV frontier is found by varying r_p and minimizing variance. The fourth set of equations specifies that negative investments in any securities are not permitted. The last set of equations places lower and upper bounds on the percentage that asset i represents of the portfolio.

Data

Adjusted per acre net income is used to determine returns, variances, and covariances for inclusion in the portfolio model. Because borrowers must be engaged

in agricultural production, adjusted per acre net income is calculated to reflect returns to farm operators. Per acre adjusted farm income is determined by adding farm mortgage interest paid and average capital gain in farm land value to average net farm income (see Jones and Barnard and U.S. Department of Agriculture for data sources). The result was then divided by total farm acres in each state. Average net farm income and farm mortgage paid represent returns to farm operators. Average capital gain, however, includes returns for farm operators and landlords. Because adjusted net income is stated on a per acres basis, this inconsistency should not bias results, unless landlords own farm land that accrues different capital gains than land owned by farm operators. Per acre adjusted farm income was calculated from 1950 through 1986 for each of the contiguous forty-eight states. It is stated in terms of 1984 dollars using the gross national product-implicit price deflator.

Adjusted per acre net income accounts only for variability of asset returns. It does not consider other factors affecting the abilities of farmers to meet mortgage payments such as nonfarm income, liquidity, leverage, and security. Therefore, adjusted per acre net income does not totally reflect risks to agricultural lending. Consistent data accounting for those factors is not available for individual states over the entire time period studied. Adjusted net income, however, does provide useful insights into risk relationships among states and regions.

Deflated adjusted per acre net income exhibited autoregressive time patterns, which can lead to incorrect estimates of variances and covariances causing portfolio model results to be suspect. To correct for time patterns, it was assumed that the state adjusted net income series exhibited a similar autoregressive pattern as that of the aggregate U.S. data series. The state data series was transformed by subtracting each observation in the U.S. data set from the observations for corresponding years in each group data set. We then checked for autoregressive time patterns by regressing lagged transformed per acre net income on transformed per acre net income. Time patterns were not found, as indicated by insignificant F values at the 5 percent test level. Also, the Bruesch-Pagen test was used to check for heteroscedasticity related to return level and time. Tests supported null hypotheses of homoscedasticity in each case.

Expected returns, variances, and covariances were then calculated using the transformed data. Expected values were found by adding the expected value of the transformed data sets and the U.S. aggregate data set. Using the transformed data slightly changes the interpretation of portfolio results. The portfolio model minimizes variance around a time trend. Therefore, the general time trend cannot be diversified away.

The above data were used to conduct two sets of portfolio analyses: (*a*) state group analysis and (*b*) FCS district analysis. The state group analysis examines potential risk efficiency gains when investments can be more freely combined, while the FCS district analysis examines risk efficiency gains possible with aggregate portfolios from each FCS district. When conducting the state group analysis, states were combined into twenty-five regions. The ten states with the largest cash receipts from commodity sales in 1986 were not combined with other states, but the remaining thirty-eight states were combined into fifteen contiguous groups based on similarities in type and size of agricultural production (see Table 1). Table 2 shows the states within each FCS district.

Expected returns, standard deviations, and coefficients of variation (CVs) for the state and FCS groups are presented in Tables 3 and 4, respectively. When calculating statistics for groups or districts, averages of the state returns within the groups or districts were taken. The range of CVs for state groups varies from 1.91 for the Montana group to 0.3 for Texas. The CV range for the FCS districts, narrower due to the effect of averaging more states into groups, ranges from a high of 1.10 for the Baltimore district to a low of 0.45 for the Texas district.

Results of the Portfolio Model

Portfolio analyzes were first conducted without any market restrictions (for

Table 1. State Groups Used in the Portfolio Analysis

1	California
2	Iowa
3	Texas
4	Nebraska
5	Illinois
6	Minnesota
7	Kansas
8	Wisconsin
9	Florida
10	Indiana
11	Washington, Oregon
12	Montana, Idaho
13	Nevada, Utah
14	Arizona, New Mexico
15	Wyoming, Colorado
16	North Dakota, South Dakota
17	Missouri, Arkansas, Oklahoma
18	Louisiana, Mississippi
19	Kentucky, Tennessee
20	Michigan, Ohio
21	Alabama, Georgia
22	North Carolina, South Carolina
23	West Virginia, Virginia, Maryland, Delaware
24	New York, Pennsylvania, New Jersey
25	Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island

Table 2. Farm Credit Districts Used in the Portfolio Analysis

FCS District	States
Springfield	Maine, New Hampshire, Vermont, Massachusetts, New York, Connecticut, Rhode Island, New Jersey
Baltimore	Pennsylvania, West Virginia, Virginia, Maryland, Delaware
Columbia	North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi
Louisville	Ohio, Kentucky, Tennessee, Indiana
St. Louis	Illinois, Missouri, Arkansas
St. Paul	Michigan, Wisconsin, Minnesota, North Dakota
Omaha	South Dakota, Wyoming, Nebraska, Iowa
Wichita	Kansas, Oklahoma, Colorado, New Mexico
Texas	Texas, Louisiana
Sacramento	California, Nevada, Utah, Arizona
Spokane	Washington, Oregon, Montana, Idaho

example, equation (5) was not included in the model). Resulting EV frontiers are shown in Figure 1 as *unrestricted state group* for the state analysis and *unrestricted FCS* for the FCS district analysis. The figure also shows points, labeled *restricted state group* and *restricted FCS*, where percentages in the state groups and FCS district match the average amount of farm real estate debt outstanding in each group or district at the end of 1987. Average amount of farm real estate debt outstanding serves as a proxy for eligible loan amounts for inclusion in pools.

In either case, significant risk gains can be obtained by combining investments in proportions not matching farm real estate debt outstanding. In addition, the unrestricted state group EV frontier is more efficient than the unrestricted FCS group frontier. This result occurs because the FCS frontier fixes investments in states at averages within the district. Thus, the model cannot combine state groups in the FCS analysis as freely as in the state group analysis.

While the unrestricted portfolios are "efficient," ten of the state groups—including Minnesota and Florida, which have significant agricultural production—are not included in any of the portfolios. In the FCS analysis, the largest district, St. Paul, is absent from all of the solutions. Moreover, some states and districts enter the unrestricted solution at unrealistically high percentages. To examine the characteristics of farm loan pools more likely to occur in the market place, restricted portfolio analyses were conducted.

In the partially restricted analyses, the state group and district percentages were required to be within 5 percent of the U.S. farm mortgage debt as of year-end 1987. In 1987, for example, 9 percent of U.S. farm land debt outstanding was in California. Therefore, the fraction of the total portfolio represented by California was allowed to vary between 4 percent and 14 percent. In addition, each state group had to represent at least 1 percent of the portfolio. Resulting lower and upper bounds are shown in the columns labeled *lower limit* and *upper limit* in Tables 5 and 6 for the state groups and FCS districts, respectively.

Resulting "partially restricted" EV frontiers

Table 3. Expected Returns, Standard Deviations, and Coefficients of Variation of Adjusted Per Acre Net Income for the State Groups and the U.S., 1950-86

State Group	Expected Return	Standard Deviation	Coefficient of Variation
CA	$298.55	$141.93	0.48
IA	200.32	174.76	0.87
TX	193.16	57.35	0.30
NE	102.34	65.56	0.64
IL	172.45	187.38	1.09
MN	139.76	105.62	0.76
KS	96.29	58.98	0.61
WI	117.16	64.35	0.55
FL	133.30	73.29	0.55
IN	104.11	148.79	1.43
WA, OR	59.61	35.89	0.60
MT, ID	42.72	31.88	0.75
NV, UT	11.51	22.01	1.91
AZ, NM	28.07	15.90	0.57
WY, CO	30.44	18.45	0.61
ND, SD	63.87	44.96	0.70
MO, AR, OK	82.31	55.33	0.67
LA, MS	64.11	73.33	1.14
KY, TN	75.91	34.97	0.46
MI, OH	82.13	85.03	1.04
AL, GA	74.65	36.89	0.49
NC, SC	85.14	82.01	0.96
WV, VA MD, DE	38.20	53.49	1.40
NY, PA, NJ	81.83	60.27	0.74
ME, VT, NH, MA, CT, RI	41.20	46.42	1.13
U.S.	47.99	41.58	0.87

are labeled in Figure 1 as *partially restricted state group* for the state group analysis and *partially restricted FCS* for the FCS system analysis. Reductions in risk efficiencies occur from the unrestricted analyses. Significant gains, however, still exist over the totally restricted points.

Table 4. Expected Returns, Standard Deviations, and Coefficients of Variation of Adjusted Per Acre Net Income for the Farm Credit System Districts and the U.S., 1950-86

FCS District	Expected Return	Standard Deviation	Coefficient of Variation
Springfield	$51.24	$47.96	0.94
Baltimore	47.11	49.89	1.10
Columbia	87.53	49.38	0.56
Louisville	86.86	82.29	0.95
St. Louis	119.18	100.90	0.85
St. Paul	98.63	62.79	0.64
Omaha	94.47	68.09	0.72
Wichita	56.79	32.99	0.58
Texas	124.53	55.63	0.45
Sacramento	89.31	45.04	0.50
Spokane	51.16	31.94	0.62
U.S.	47.99	41.58	0.87

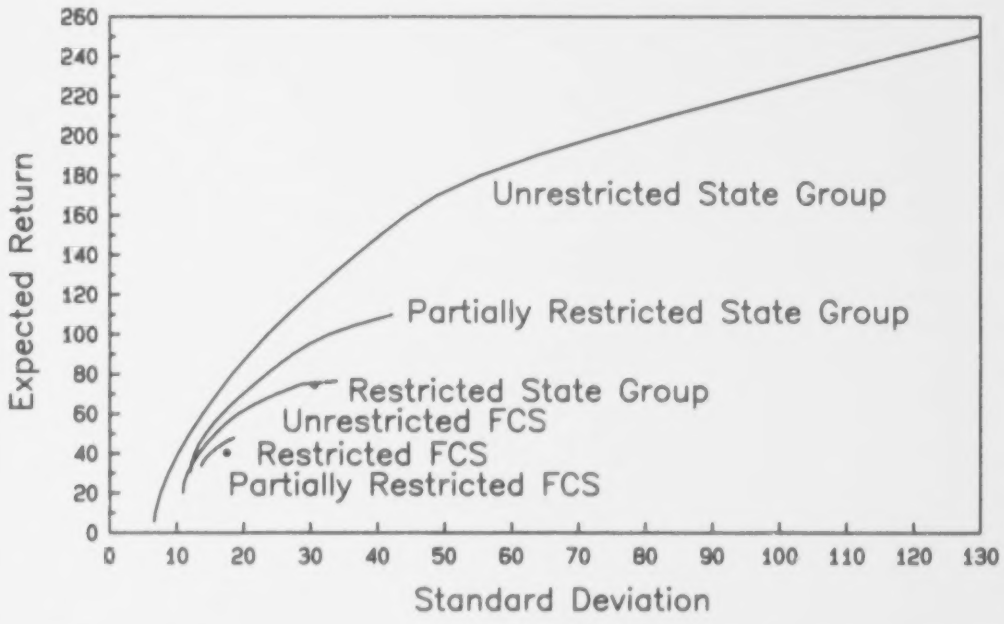
Selected resulting portfolio compositions for the state group analysis are presented in Table 5. The portfolios range in expected return from $30.87 to $110 and range in standard deviation from $12.03 to $42.21. As expected, most of the state groups not entering the unrestricted portfolios at a particular return level, enter into the partially restricted portfolios at the lowest levels allowed. Sometimes, however, those groups enter into the partially restricted portfolios at the maximum levels allowed. At relatively higher expected return and standard deviation levels, the portfolios include significant percentages in large agriculture producing state groups—California, Iowa, Texas, Wisconsin, Florida, and the New York, Pennsylvania, and New Jersey state groups.

Compositions of partially restricted FCS district portfolios are presented in Table 6. The partially restricted portfolio with the lowest return, $33.88, has a standard deviation of $13.67. The highest return possible for the partially restricted portfolios is $48, with a standard deviation of $18.52. The St. Paul district is forced into the solution at the minimum level for the lower return portfolios. But the fraction invested in the St. Paul district gradually increases in the higher return portfolios. In general, half of the investments are at either their minimum or maximum allowable percentages.

Mergers of Current FCS Districts

The Agricultural Credit Act of 1987 requires that FCS districts consider merging, resulting in no fewer than six FCS districts. In this section, a heuristic approach is used to examine potential mergers based on correlations of adjusted per acre net income. This approach does not necessarily yield an optimum. Solving for an optimum would require a complex programming approach, presenting great difficulty in objective function specification. Also, the analyses do not consider the present financial condition or loan volumes of the

Figure 1. Efficient Frontiers for State Group and FCS District Portfolios



FCS districts, which are important considerations. However, the heuristic analyses have value because they do consider income correlations. Merging districts with less than perfectly positive correlations should result in less risk emanating from agricultural lending. Two merger possibilities are presented: (*a*) mergers of existing FCS districts and (*b*) mergers without regard for current FCS districts.

Mergers of existing FCS districts. Combining districts that have low or negative correlations provides the greatest gains in risk reduction. Such districts, however, generally lie in different regions of the country (Table 7). Contiguous districts are highly desirable from an operational standpoint. Unfortunately, under the contiguous district constraint, gains in risk reduction are diminished. Nevertheless, some gains are still possible.

For example, the Spokane district could be merged with either the Sacramento, the St. Paul, or the Omaha districts. The Spokane district has a positive correlation with the Sacramento district of 0.44, a low correlation of 0.12 with the St. Paul district, and a negative correlation of −0.13 with the Omaha district. Therefore, merging the Spokane and Omaha districts should achieve the most risk reduction.

The only possible merger remaining for the Sacramento district is with the Wichita district. Their correlation is 0.44. The other possible mergers for the Wichita district are with either the St. Louis or Texas districts. The correlation of the Wichita and St. Louis districts is −0.50, while the correlation of the Wichita and Texas districts is 0.19. Therefore, more risk reduction occurs if the Wichita and St. Louis districts are merged. That leaves the Sacramento district with no merger possibilities. The state group correlations indicate, however, that the correlations between California and the two neighboring state groups of Nevada and Arizona are near zero, suggesting that Sacramento is already well diversified.

The only contiguous merger possibility remaining for the St. Paul district is with the Louisville district. The correlation coefficient for those two districts is 0.43. Another possibility, however, would be to merge the St. Paul and Springfield districts. Geographically, they are not contiguous, but they are both in the north and northeast quarters of the U.S. The correlation between

Table 5. Composition of Portfolios From the Partially Restricted State Group Analysis

State Group	Lower Limit[1]	Selected Portfolios					Upper Limit[2]
CA	4%	4.0%	5.8%	11.4%	14.0%	14.0%	14%
IA	3	3.0	4.4	6.8	13.0	13.0	13
TX	2	3.9	12.0	12.0	12.0	12.0	12
NE	1	1.0	1.0	1.0	1.0	1.0	9
IL	1	1.0	1.0	1.0	3.1	8.8	11
MN	1	1.0	1.0	1.0	1.0	9.0	10
KS	1	1.0	1.0	1.0	1.0	1.0	8
WI	1	1.0	6.1	7.2	8.0	8.0	8
FL	1	1.0	1.0	1.0	8.0	8.0	8
IN	1	1.0	1.0	1.0	1.0	1.0	9
WA, OR	1	6.4	2.3	1.0	1.0	1.0	9
MT, ID	1	9.0	9.0	1.0	1.0	1.0	9
NV, UT	1	6.0	1.0	1.0	1.0	1.0	6
AZ, NM	1	7.0	2.9	1.0	1.0	1.0	7
WY, CO	1	8.0	1.0	1.0	1.0	1.0	8
ND, SD	1	1.0	1.0	1.0	1.0	1.0	9
MO, AR, OK	3	3.0	3.0	3.0	3.0	3.0	13
LA, MS	1	8.0	8.0	5.4	1.0	1.0	8
KY, TN	1	8.0	8.0	8.0	8.0	1.0	8
MI, OH	1	10.0	10.0	8.3	1.0	1.0	10
AL, GA	1	1.0	2.7	8.0	1.0	1.0	8
NC, SC	1	3.6	6.9	8.0	7.9	1.2	8
WV, VA, MD, DE	1	7.0	1.0	1.0	1.0	1.0	7
NY, PA, NJ	1	3.0	8.0	8.0	8.0	8.0	8
ME, VT, NH, MA, CT, RI	1	1.0	1.0	1.0	1.0	1.0	6
Portfolio:							
Standard deviation ($)		12.0	16.8	23.4	32.7	42.2	
Return ($)		30.9	60.0	80.0	100.0	110.0	
Coefficient of Variation		.39	.28	.29	.33	.38	

[1]Gives the lower percent restriction on the asset's composition of the portfolio.

[2]Gives the upper percent restriction on the asset's composition of the portfolio.

the St. Paul and Springfield districts is −0.25, so substantial risk reduction is attained.

The Louisville district achieves the most risk reduction by merging with the Columbia district. Their correlation coefficient is 0.07. The Baltimore district achieves greater gains in risk reduction through merger with the Columbia and Louisville districts, than through merger with the Springfield district, so the Baltimore district is merged with the Louisville and Columbia districts. The Texas district is not merged, but Texas already has the lowest coefficient of variation of all the FCS districts, so leaving it unmerged is reasonable. Figure 2 shows a map of the resulting FCS districts.

Mergers without regard for current district boundaries. Allowing present FCS districts to be split and realigned into new districts, as opposed to merging existing districts, allows more opportunities to reduce lending risks. Six FCS districts are formed using a heuristic approach based on correlations among state groups, with the stipulation that the districts must consist of contiguous states. Six districts are formed because the Agricultural Credit Act of 1987 stipulates that no fewer than six FCS districts will be allowed. The first step in the heuristic process is to note which state groups are highly correlated. Second, low or negative correlations among groups are noted. Considering the total geographic size of each district and the stipulation of contiguous states, the six new FCS districts presented in Figure 3 are formed. The South Central district exemplifies the process of determining the new districts.

Iowa, Illinois, and Indiana are all highly

Table 6. Compositions of Portfolios From the Partially Restricted Farm Credit System Analysis

FCS District	Lower Limit[1]	Selected Portfolios				Upper Limit[2]
Springfield	1%	3.6%	3.2%	4.0%	1.8%	7%
Baltimore	1	9.0	1.0	1.0	1.0	9
Columbia	6	7.6	13.2	16.0	16.0	16
Louisville	5	8.6	11.4	8.4	5.0	15
St. Louis	6	6.0	6.0	6.9	13.5	16
St. Paul	8	8.0	8.0	10.0	15.9	18
Omaha	9	9.0	9.0	15.5	10.8	19
Wichita	4	14.0	11.6	4.0	4.0	14
Texas	3	13.0	13.0	13.0	13.0	13
Sacramento	6	8.2	10.5	16.0	16.0	16
Spokane	3	13.0	13.0	5.1	3.0	13
Portfolio:						
Standard Deviation ($)		13.7	14.4	16.4	18.5	
Return ($)		33.9	38.0	44.0	48.0	
Coefficient of Variation		.40	.38	.37	.39	

[1]Gives the lower percent restriction on the asset's composition of the portfolio.

[2]Gives the upper percent restriction on the asset's composition of the portfolio.

correlated and exhibit high standard deviations of adjusted income. So those states should not be in the same district. For Illinois, this leaves potential alignment with Wisconsin or the Missouri group. Wisconsin and Illinois have a low correlation, 0.05. The correlation for Illinois and the Missouri group is 0.23. The Missouri group is more highly correlated with Kansas, 0.42, but less correlated with Texas, 0.17. Further, Illinois and Texas are negatively correlated, −0.50. Therefore, Texas, Illinois, and the Missouri group form the South Central district. A similar process is followed to form the remaining five districts.

This arrangement of districts shows how the states may be aligned to form FCS districts. The results do not consider other factors relevant to forming FCS districts such as the resulting size of district loan portfolios or current district financial conditions. Nor does the analysis necessarily yield an optimum. Nonetheless, the analysis does provide useful insight into what may be appropriate FCS districts.

Summary and Conclusions

Risk efficiencies emanating from agricultural asset returns can be gained by combining assets from differing geographical regions of the country. When forming farm real estate loan pools, having loans from the Far West (for example, California), the Southwest (for example, Texas), and the Midwest (for example, Iowa) appears crucial in gaining risk efficiency. For higher rates of return, pools should consist of more farm loans

Table 7. Correlation Matrix of Adjusted Per Acre Net Incomes for Farm Credit System Districts, 1950-86

FCS District	Spring.	Balt.	Col.	Louis.	St. Lo.	St. Pa.	Omaha	Wich.	Texas	Sacra.	Spokane
Springfield	1.00										
Baltimore	0.44	1.00									
Columbia	0.24	0.32	1.00								
Louisville	0.33	0.33	0.07	1.00							
St. Louis	−0.47	0.15	0.00	0.87	1.00						
St. Paul	−0.25	0.01	0.13	0.43	0.57	1.00					
Omaha	−0.10	0.20	−0.04	0.44	0.66	0.60	1.00				
Wichita	0.57	0.12	0.20	−0.58	−0.50	0.04	0.10	1.00			
Texas	−0.20	−0.21	0.17	−0.13	−0.06	0.15	−0.19	0.19	1.00		
Sacramento	0.18	−0.25	0.21	−0.42	−0.31	0.18	−0.13	0.44	0.25	1.00	
Spokane	0.37	−0.23	0.05	−0.59	−0.54	0.12	−0.13	0.68	0.09	0.60	1.00

Figure 2. Proposed Mergers of FCS Districts without State Realignments

Figure 3. Proposed Mergers of FCS Districts with State Realignment

from the Far West, Midwest, and the Great Lakes states.

One consideration when merging Farm Credit System districts should be correlations of agricultural returns. Analyses suggest that correlations can be considered while still having contiguous districts. While combining states in this manner will not guarantee the success of new Farm Credit System districts, it should place the resulting districts on more solid financial footing.

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Lender Liability: Nature, Extent, and Economic Impact of Agriculturally Related Claims in North Dakota

Cole R. Gustafson and Peter J. Solemsaas

Abstract

Agricultural borrowers expect certain levels of lender performance that include conditions under which loans are accelerated, extended, and renewed as well as proper lender conduct. When lenders fail to perform satisfactorily, borrowers raise claims of "lender liability." In a survey of North Dakota commercial banks, 22 percent of the respondents were involved in at least one case of lender liability. Failure to advance funds under a loan agreement without due notice and interference with a borrower's business were the most frequently cited claims.

In response to actual or feared claims of lender liability, commercial banks have increased interest rates on farm loans, have reduced credit availability, and have purchased formal insurance. In addition, lenders improved loan documentation and increased training in an effort to reduce the likelihood of future claims.

Key words: agricultural loans, economic effects, insurance, lender liability, survey.

Debtor-creditor relations in agricultural capital markets have changed significantly during the 1980s. The Agricultural Credit Act of 1987 affords debtors numerous "borrower rights." (Public Law no. 100-233, 1988). Those rights encompass access to loan documents, information on differential interest rates, an appeal process, and methods for restructuring delinquent loans. The economic impact of borrower rights includes higher interest rates on agricultural loans, fewer financial services, and reduced capital availability (Gustafson et al. 1987).

However, creditors have also undertaken actions that affect debtor-creditor relations. General deregulation of financial institutions has resulted in lower margins on agricultural loans due to elimination of interest rate controls on deposits and more market-oriented pricing of loans (Barry). Another factor contributing to lower margins is the recent period of financial stress in the agriculture sector (Morehart et al.). One consequence of lower margins on agricultural loans is closer loan supervision as lenders attempt to limit downside risks associated with nonpayment of interest and principal (Lee and Baker). In addition, improved methods of credit scoring encourage lenders to more precisely evaluate (monitor) the credit worthiness of borrowers before (after) credit is extended (Lufburrow et al.). Thus, closer observation and more quantitative analyses have heightened the competency of lenders, their knowledge, and their involvement in borrower's farm operations.[1]

Cole R. Gustafson is an assistant professor, and Peter J. Solemsaas is a graduate student, both in the Department of Agricultural Economics, North Dakota State University. The authors appreciate the comments of David Saxowsky and two anonymous reviews on an earlier draft of the manuscript; the assistance provided by Keith Magnusson, North Dakota Bankers Association, when conducting the survey; and the information provided by the commercial bankers in North Dakota on which the results of this study are based. North Dakota Experiment Station paper no. 1748.

[1]Of course, the degree to which a lender becomes involved in an individual loan depends on the loan amount being considered, collateral values, characteristics of the bank's lending portfolio, and

In this setting, borrowers have come to expect certain levels of lender performance. Those levels include conditions under which loans are accelerated, extended, and renewed as well as proper lender conduct. When lenders fail to achieve those levels, borrowers raise claims of "lender liability." Three factors accounting for the rise in lender liability claims according to Harl include "a sharp increase in financial fraud involving banks—up from $200 million in 1980 to about $1.15 billion in 1986; deepening financial stress in the agricultural sector, which has strained traditional lender-borrower relationships; and an apparent willingness of unhappy customers to pursue their grievances in court."[2]

This article determines the extent of lender liability claims among commercial banks in North Dakota, identifies characteristics of borrowers who raise such claims, and examines changes banks have undertaken in response to those claims. Information to estimate those relationships was obtained by survey. The next section examines the many facets of lender liability. Following sections describe the procedures and empirical results of the survey. The final section of the article summarizes research implications of this study's findings.

Nature of Lender Liability Claims

Claims of lender liability are not a recent phenomena (Borders). Financial institutions have always been liable for the acts of their employees and directors. Even though directors may have little formal training in financial institution management, they are required to exercise good judgment and diligence and possess a working knowledge of the business.

Lender liability claims generally arise in one of two forms: a direct action by the farmer against a lender or as a counterclaim to a lender's foreclosure suit. Legally, there are numerous possible claims and borrowers frequently assert more than one claim; usually one based on contract law and the other in tort (Bahls). However, they can be broadly classified as follows:

Displayed lack of good faith and fair dealings. A lender failed to advance funds under an existing loan agreement without giving a proper warning. Damages to the borrower's business arise if he is unable to obtain alternative funding and must abandon his projects.

Improperly accelerated or foreclosed an existing loan. Lenders cannot rely upon provisions in their loan documentation that permit them to call a loan or continue a long-term financing relationship without due notice. Unless a lender is taking defensive action to protect the interests of his institution, a borrower must be given a reasonable period of notice so that alternative financing arrangements can be made.

Breach of fiduciary duty. Lenders exercising control over a borrower's business expose themselves to the risks of being a fiduciary. Actions such as taking command of a borrower's business or premises, becoming sole signatory on the borrower's checks, or selectively paying the borrower's creditors indicate lender control. A related claim involves ill-fated expansion whereby a lender encouraged a previously debt-free operation to borrow for expansion purposes. This does not imply that a lender's fiduciary duty is nil. On the contrary, lenders do have a responsibility to those with which it does business. Harl states the courts have imposed this level of care because banks are highly regulated, banking involves a vital public service affecting public welfare, customers depend upon the bank's expertise, and there is a perceived imbalance of economic power between the bank and its customers.

Lack of professionalism. This category includes unsafe and unsound banking practices such as negligent processing of loan applications, failure to respond to

other factors affecting the risk associated with the loan.

[2]Borders notes that the judicial system is also more willing to deal with contractual terms between lenders and borrowers, "The restraint the judiciary has exercised with respect to standard commercial contracts has, at least until recently, characterized the commercial lending area . . . In recent years, however, the judiciary has intruded into the commercial lending area."

information requests, or overcharging of interest.

Original terms of a loan agreement are the result of acquiescence on the part of both lender and borrower. Traditionally, courts have allowed lenders to enforce contracts embodied in the loan agreement. With the advent of lender liability, lenders must now exercise greater care when dealing with debtors. The effect of lender liability is a redefinition of the contract in the borrower's favor. The adverse economic impacts of lender liability claims on the profitability of a financial institution are conceptualized in Appendix 1.[3]

Survey Procedure

Data to estimate the extent and nature of lender liability claims were obtained from a survey of commercial banks in North Dakota. The geographic region was selected for three reasons. First, the state is in a region experiencing high levels of financial stress (Morehart et al.). Second, North Dakota has numerous statutory laws governing debtor-creditor relations (Gustafson et al. 1987), which implies borrowers actively pursue legal concerns. Those two factors were expected to heighten incidence of lender liability claims.[4] Third, North Dakota is a unit banking state. Thus, North Dakota banks tend to be of smaller size than those located in states that permit branching. Due to their small size and limited diversification opportunities, North Dakota banks are likely to have greater firm-level financial effects from claims of lender liability.

[3]In addition to economics, lender liability can be criticized on social, liberty, and fairness grounds (Borders). According to the "equity theory" of social psychology, satisfied borrowers feel inequity if they continue to abide by their contractual obligation. Eventually, they too are likely to breach their contract.

[4]The purpose of this study was not to extrapolate results of the study to other regions or infer levels of lender liability nationwide. Instead, the focus was to identify the nature of claims being raised and the resulting economic effects on the performance of agricultural credit markets. Consequently, a region expected to have a high frequency of claims was selected.

The survey instrument consisted of six sections.[5] Details regarding the frequency of lender liability cases during the past year, at the present, and expectations for the coming year were elicited in section A. Information on the nature of each of the cases, whom the cases were raised against, the characteristics of the plaintiff, and the value of damages, was identified in section B. Lenders were instructed that a single case may involve more than one claim or basis for the action by the plaintiff. Section C was an open-ended question whereby lenders were asked what actions have been undertaken to reduce the likelihood of future claims. Data on the costs of lender liability to the bank were obtained in sections D and E. Data regarding the financial characteristics of the bank were obtained in the final question.

The surveys were distributed July 5, 1988, to all 172 federal, state, and independently chartered commercial banks in the state. Commercial banks held approximately 11 percent of the outstanding real estate debt and 41 percent of the nonreal estate debt extended to North Dakota farmers in 1987 (U.S. Department of Agriculture).

Results

Usable surveys were obtained from 110 institutions, a response rate of 64 percent. Total agricultural loan volume reported by those banks was $829.2 million, which represents 85 percent of all agricultural debt held by commercial banks in the state.

Of the 110 respondents, twenty-four reported that they had previously been, were currently in, or expected to be involved in a legal case of agriculturally related lender liability. Most of the institutions experiencing lender liability were involved in more than one case. There were sixteen respondents who were currently involved in a case, while seventeen respondents had been involved in a case that concluded during the previous twelve months (as a result of borrower withdrawal, negotiated settlement, or judicial decision). Respondents from eleven banks expected to be involved in additional

[5]Copies of the survey instrument are available upon request from the senior author.

cases during the next twelve months. The geographic locations of the cases were not statistically related.

The various bases of lender liability raised by borrowers are summarized in Table 1. A single case may involve more than one claim or basis for action. The most frequently raised claims were the lender (*a*) displayed lack of good faith and fair dealing (for example, failed to advance funds under a loan agreement without due notice) and (*b*) showed fraud, duress, and interference with the debtor's business affairs (for example, threatened to declare a loan in default when the bank had made no decision or did not plan to call the loan).

Claims that were not mentioned by the bankers included (*a*) conflict of interest (lender encouraged borrower to purchase assets in which the bank had an interest) and (*b*) failed to reveal a conflict of interest.

Claims of lender liability were raised against the financial institution in twenty-seven instances and against the loan officer in eight instances. There was only one reported case of lender liability against an officer or a director of a bank.

Table 1. Claims of Lender Liability

Survey Questions	Cases Concluded During Past 12 Months	Current Cases	Expected Cases During Next 12 Months	Total
Exercised control over debtor's business (includes taking over management, installing an agent to manage affairs, promising payments to other creditors on behalf of borrower)	1	4	0	5
Displayed lack of good faith and fair dealing (e.g., failed to advance funds under a loan agreement without due notice)	6	9	2	17
Improperly accelerated or foreclosed on a loan (includes not providing notice of change in lender-borrower relationship)	0	3	0	3
Showed fraud, duress, and interference with the debtor's business affairs (e.g., threatened to declare a loan in default when bank had made no decision or did not plan to call the loan)	1	9	1	11
Failed to provide full information to a debtor with a material question	0	1	0	1
Displayed negligent processing of loan applications	0	1	2	3
Failed to negotiate in good faith under a loan agreement	1	4	0	5
Overcharged interest	0	0	1	1
Encouraged borrower to purchase assets in which bank had an interest (conflict of interest)	0	0	0	0
Did not provide necessary expertise to a debtor	1	1	1	3
Interfered with the debtor's relation with another party	0	1	3	4
Improperly applied debtor's assets to reduce debtor's obligation to your institution	1	1	0	2
Failed to reveal a conflict of interest	0	0	0	0
Other bases	6	6	0	12

Compensatory and punitive damages sought by borrowers averaged $595,250 and $3,040,000, respectively. Those amounts are not normally distributed as a few large claims well above the mean exist (skewness = 1.73 and 1.91, respectively). The damages sought are also far greater than actual damages on cases that concluded in the past twelve months, which averaged $10,000 and $16,000, respectively.[6]

Characteristics of borrowers who raised the claims were elicited from the respondents. On average, those borrowers were 47.6 years of age and had 0.56 years of education beyond high school. Farms operated by the borrowers were not significantly ($p = 0.05$) different in size than the state average (Gustafson et al. 1989). Borrowers raising claims had been customers of the bank for an average of 12.4 years. Based on the judgment of the bank, 89.5 percent of the borrowers were in financial trouble. Of those in trouble, 44 percent had had their loans restructured at an earlier date.

The characteristics of banks with claims raised against them are mixed. On one hand, smaller banks experienced a larger number of claims while banks with a larger number of branches, which would presumably be of larger size, also had a greater number of claims as shown by the following regression:

$$CLAIM = .35 - .0000056\ SIZE \quad (-3.03) + .33\ BRANCH, \quad (4.54)$$
$$R^2 = .18$$

where *CLAIM* is the total number of past, present, and future cases of lender liability experienced by the creditor; *SIZE* is the total assets of the bank; and *BRANCH* is the total number of domestic facilities. *T*-values indicating variable significance are shown in parentheses. The number of claims could not be related to bank profitability, the percentage of the bank's loan portfolio that was agriculturally related, the level of a bank's nonaccrual agricultural loans, or whether the bank was nationally or state chartered.

The 110 survey respondents indicated lender liability has increased their cost of doing business and has reduced the amount of credit available to farm borrowers. In response to either actual or anticipated cliams, bankers have increased interest rates an average of 8.7 basis points. The value is significantly different than zero ($T = 4.85$) and uncorrelated with bank size (Pearson correlation coefficient $\rho = -0.04$). Therefore, on total agricultural loan volume of $974 million held by commercial banks in North Dakota, farmers patronizing banks in the state are incurring $847,380 of additional interest charges annually as a direct result of lender liability. The quantity of loanable funds available to farmers has been reduced an average of 4.56 percent. Again, the value is significantly different than zero ($T = 4.38$) and uncorrelated with size ($\rho = -0.11$).

Even though only one claim of lender liability was raised against an officer or director of a commercial bank, they, too, are affected economically. A total of five officers left their positions as a result of liability insurance that was too costly or unavailable. Another eighteen dropped their liability insurance because of costly premiums.

To guard against future lender liability claims, 59.1 percent of the commercial banks purchased insurance with an average policy value of $6.242 million. Insurance could result in a lower cost of doing business if risks associated with lender liability are transferred to other entities. In this study, a lender's purchase of insurance leads to a smaller rise in farm interest rates as evidenced by the following regression equation estimated with the survey data:

$$BASISPTS = 2.04 + 8.66\ CLAIM \quad (2.07) - 7.37\ INSURE \quad (-2.09)$$

[6]Both of the anonymous reviewers requested additional information as to the settlement terms on cases that had been concluded. In an effort to minimize respondent burden, that information was not elicited. Further research in this specific area appears warranted.

$$+ 9.66\ DIRECT,$$
$$(2.19)$$
$$R^2 = .11$$

where *BASISPTS* represents each bank's increase in farm interest rates due to actual or feared claims of lender liability in basis points; *CLAIM* is the total number of past, present, and future cases of lender liability experienced by the creditor; *INSURE* is a dummy variable reflecting the purchase of insurance; and *DIRECT* is the number of financial institution officers and directors that have left as a result of lender liability. *T*-values indicating variable significance are shown in parentheses.

Moreover, lenders were undertaking a number of strategic actions to reduce the likelihood of future claims (Table 2). Paramount was better documentation of a borrower's performance and communication with the borrower. Obtaining additional training and education on the fiduciary duties of loan officers and officers of a bank was also viewed as important.

Summary

This study examined the extent and nature of agriculturally related lender liability claims affecting commercial banks in North Dakota. Twenty-two percent of the banks surveyed stated they are involved in at least one case of lender liability. Failure to advance funds under a loan agreement without due notice and interference with a borrower's business were the most frequently cited claims.

Table 2. Lender Actions Undertaken to Reduce Likelihood of Future Claims

Action	Frequency of Response
Better Documentation	25
Additional Training and Education	14
Use Attorneys More	12
Attend Lender Liability Seminars	10
Increased Communication with Customers	10
Tighten Lending Criteria	8
Don't Make Production or Management Decisions for Borrowers	5
Change Bank Policies	5
Develop Consistent Loan Terms and Policies	3
Additional Monitoring of Borrowers	3
Honor Existing Commitments	3
Other	13

In response to actual or feared claims of lender liability, commercial banks in this survey have increased interest rates on farm loans and have reduced credit availability. In addition, lenders have purchased formal insurance and have improved loan documentation in an effort to reduce the likelihood of future claims.

The results of this study are limited to the state of North Dakota. Overall effects on agricultural capital markets could be gauged in an expanded survey that includes other agricultural lenders and geographic regions of the country. In addition, a companion study investigating the economic effects of lender actions on the financial well-being of borrowers in actual occurrences of lender liability appears warranted. Such a study could compare the characteristics of borrowers who do file lender liability claims with those of who do not file. Finally, the impact of a secondary mortgage market in agriculture on lender liability issues needs to be investigated.

Appendix 1

To illustrate the effects of lender liability on the profitability of a financial institution, we assume a bank with agricultural loan volume (l). A portion of the funds ($0 < q < 1$) have been lent to borrowers claiming lender liability, and the remainder ($1 - q$) have been lent to borrowers satisfied with the bank's services.

The rates of return on loans to each class of borrowers are (r) and (s) percent, respectively. Rate r is the contractual interest rate charged to satisfied borrowers. For simplicity, only one rate exists, which assumes lenders do not discriminate among borrowers of varying credit worthiness. Moreover, the analysis excludes fees and charges received for services rendered, which are considered a separate profit center.

The rate of return on loans held by bank customers raising lender liability cases includes interest (t) if the borrower is not in default, plus the present value of any negotiated settlement (n) or legal award (a), less legal fees and retainers (f), expressed as a percent of the outstanding loan balance. Terms (n) and (a) are unknown variables at the present. They are likely to be negative, but their exact level is uncertain and high variable geographically, intertemporally, and across farms with different structural characteristics. The nominal values of n and a are also discounted by the lender's opportunity cost of funds (d) to reflect the length of the litigation process in years (y)

$$s = t + (n + a)(1 + d)^{y} - f. \qquad (1)$$

Expenses directly associated with loan volume include cost of funds (i) and variable expenses (v). Funding costs are a weighted average of interest payments on bank liabilities and returns to equity capital. Variable expenses include salaries, rents, equipment, supplies, taxes, and other administrative costs that vary with the size of the loan portfolio. In addition, variable expenses include the opportunity cost of reserves maintained to meet unanticipated funding needs, loan losses, and other institutional risks. Finally, the lender incurs numerous fixed overhead costs (o) for management, directors, insurance, and so forth.

Given the above variable specifications, profit (π) on the loan portfolio can be specified as

$$\pi = [sq + r(1-q) - i - v]l - o, \qquad (2)$$

which ensures lending revenue sufficiently covers funding, variable, and fixed costs of operation, as well as compensates for the risks associated with the lender's portfolio (Barry and Calvert). Changes in the proportion of borrowers who claim lender liability impact the profitability of a bank as follows

$$d\pi/dq = \left(t + \frac{(n + a)}{(1 + d)^{y}} - f + \frac{dr}{dq} - r - \frac{di}{dq} - \frac{dv}{dq}\right) l + \left[\left(t + \frac{(n + a)}{(1 + d)^{y}} - f\right) q + r(1 - q) - i - v\right] \frac{dl}{dq} - \frac{do}{dq} \qquad (3)$$

which is determined by substituting equation (1) for s and differentiating. Obviously, increasing claims of lender liability result in a greater share revenue originating from borrowers raising the claim (the components of s) and reduced revenue from satisfied customers (r).[7]

However, increased claims also affect expenses of the institution. The uncertainty of future negotiated settlements and awards may cause equity holders to demand higher risk premiums on their investment. Likewise, the potential of a large award may cause demand and time depositors concerned with bank liquidity to seek safer investment alternatives at competing financial institutions. To offset fund withdrawals, lenders may raise rates of return on deposits, which leads to higher costs of funds. As a result, the institutions weighted average cost of capital increases; that is, $di/dq > 0$.

Variable expenses rise ($dv/dq > 0$) due to increasing amounts of staff time dedicated to working with legal counsel and the opportunity cost associated with larger reserves that must be set aside to meet liquidity and risk needs. Liquidity declines when costs of the legal process are incurred before returns from lending to borrowers raising claims of lender liability are received.

Fixed costs climb ($do/dq > 0$) as a result of higher premiums for directors' liability insurance. Even though the bank is not directly responsible for payment of those premiums, additional perks may be granted in an effort to retain existing directors. If a director were to leave, the bank would incur additional search and administrative costs.

Loan volume declines ($dl/dq < 0$) as

[7] It is assumed competitive market conditions limit increases in interest charged to satisfied borrowers (r). Therefore, r is not a function of lender liability claims (q).

previously satisfied borrowers decide to patronize other lenders. Reasons for leaving may include perceived changes in bank policy, expectations of unfavorable treatment, and/or abrupt discontinuation of existing credit lines.

Considering all of the individual factors affecting bank revenue and expenses, the overall financial impact of rising lender liability claims is lower bank profitability.*

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*This assumes a micro, firm-level analysis. The aggregate impacts of general rise in lender liability lead to increased transaction costs in capital markets, which in turn result in lower financial intermediation, capital investment, and economic activity in an economy.

Estimates of Farm Tax Progressivity After Tax Reform

Clifford Rossi and Ron Durst

Abstract

The Tax Reform Act of 1986 (TRA of 1986) resulted in the most comprehensive overhaul of the tax code in more than thirty years. An examination of average tax rates for farm sole proprietors prior to the TRA of 1986 revealed a somewhat progressive tax system. Despite sharp reductions in marginal tax rates, the effective progressivity of the federal income and self-employment taxes for farm proprietors increased as a result of base-broadening provisions. A large part of this increase can be attributed to the elimination of preferential tax treatment for capital gains. Restoring the prereform exclusion would drastically reduce progressivity by lowering average tax rates for high income taxpayers by as much as 40 percent.

Key words: tax policy, progressivity, Tax Reform Act of 1986.

The TRA of 1986 resulted in the most comprehensive overhaul of the tax code in more than thirty years. The act substantially reduced marginal tax rates and broadened the income tax base by eliminating many of the exclusions, deductions, and credits that had been introduced into the tax code over the years.

One of the primary objectives of the TRA of 1986 was to improve fairness by reducing the opportunity to shelter income from tax through the many exclusions, deductions, and credits that were contained in the tax code. The "tax expenditures" reduced the progressivity of the tax system to the point that average tax rates actually declined at the highest income levels (Office of the President).

TRA of 1986 eliminated many tax preferences including the exclusion for long-term capital gains, the investment tax credit, and state and local sales taxes. The new law phases out the consumer interest deduction over a four-year period with complete elimination by 1991. Deductions for individual retirement account contributions for taxpayers with adjusted gross income below $25,000 ($40,000 for joint returns) or for those not covered by another retirement plan were retained in the new law. The act also replaced the fourteen tax brackets with rates ranging from 11 to 50 percent with two tax brackets with rates of 15 and 28 percent. The top rate was reduced from 50 to 33 percent.[1] Despite the sharp reduction in marginal tax rates, resulting in a less graduated rate structure, TRA of 1986 actually increased the overall effective progressivity of the

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[1] A 5 percent surcharge is levied on certain income levels taxed at the 28 percent rate to phase out the benefit of the 15 percent tax rate and the personal exemption (see Table 1).

personal federal income tax system (Office of the President).

This paper examines the effect of the TRA of 1986 on the effective progressivity of the personal federal income and self-employment taxes for farm sole proprietors. In light of recent proposals to restore preferential treatment for capital gains, the effect of reinstating the prereform exclusion is also examined. A tax accounting model simulating the effects of tax reform and pre-TRA law on farm proprietors is used to compute average effective tax rates over different income levels. A Lorenz curve and a Suits index analysis are employed to compare progressivity among the various tax structures.

Data and Methods

An Internal Revenue Service (IRS) data base of more than 15,000 taxpayers reporting farm income for the 1982 tax year is used in the analysis. Each record contains the reported entries for the tax schedules filed by the taxpayer. Thus, the data provide fairly comprehensive coverage of pre-TRA tax law. The IRS developed weighting factors that converted sample records to their representative share of the taxpayer population. The results presented were generated from the sample and weighted by the IRS factors.[2] The IRS estimates that approximately 2.69 million farm sole proprietorships filed tax returns in 1982. About 2.2 million reported tax liability totaling $11.4 billion. Despite the above figures, a high incidence of returns claiming farm losses is present in the data. Reinsel, for instance, noted that 65 percent of U.S. farm proprietors showed farm losses.

Tax Simulation Model

While the effects of tax policy on farmers and the agricultural sector have received considerable attention in the literature, few empirical studies of distributional tax effects exist at the aggregate level. Work by Hanson and Eidman (1986) provided insight into the importance of tax expenditures under periods of low economic growth. In another analysis, the authors (1985) developed a tax expenditure computation model that found a decline in tax progressivity during the years 1973–78.

An agricultural tax simulation model was developed to estimate federal income tax liability for taxpayers reporting farm income and losses. Tax simulation models have been used before in agricultural tax analysis. In their work, Hanson and Eidman (1985) computed tax expenditures on an annual basis using farm income data in a sample of Minnesota farms. Estimates of taxes reflected changes in the tax code occurring between the years 1973–78. Tax simulation models have also been used extensively for tax burden assessment under differential tax structures. For example, Neubig and Sullivan developed a model that simulated the effects of tax reform on commercial banks by estimating tax liability using financial statements of more than 14,000 banks. Models based upon large tax data bases have been used to evaluate differences between tax structures. Recently, the State of Colorado (Colorado Department of Revenue) compared tax burdens and tax distributions between pre- and post-TRA of 1986 laws for individual taxpayers using a sample of state returns.

One particularly difficult problem associated with tax analysis is that impacts occur incrementally over time. TRA of 1986 was actually phased in over a few years, and this analysis reflects the fully implemented version of tax reform. All of the above simulations suffer from a common problem; namely, that they operate within a partial equilibrium framework. Certain tax effects in this framework are ignored. For example, changes in tax policies affect demand and supply for capital investment. However, the analysis allows for comparisons of tax structures of like income patterns, so that the direct effects of individual tax changes can be observed.

The model computes individual tax liability under the pre-TRA of 1986 law after modifying each of the 15,000, 1982 tax returns to reflect the pre-TRA of 1986 tax provisions. Similarly, each farm proprietor's tax liability under TRA of 1986 provisions

[2]For additional information on the creation of these weights, see *Sole Proprietorship Returns—1982*, Statistics of Income, Internal Revenue Service.

given in Table 1 is estimated as well using reported farm and off-farm income. Tax liability is estimated for a single tax year, and aggregate farm proprietor tax liability is computed by summing the IRS weighted observations. While the most relevant provisions in the tax law are incorporated into the model (Table 1), certain simplifications were necessary as a result of data limitations. Moreover, some provisions

Table 1. Summary of Tax Changes Considered in the Simulation Model

Tax Provision	Pre-TRA	TRA
Marginal Tax Rates	14 brackets 11% bottom rate 14% over $4,530 25% over $22,880 33% over $24,310 50% over $171,580	2 brackets 15% bottom rate 28% percent over $29,750
Personal Exemption	$1,080	$2,000 (1989)
Income Averaging	Allowed if income is $3,000 more than 140% of prior three-year average income.	Repealed
Investment Tax Credit	Rate of 6 or 10% for most types of depreciable farm capital.	Repealed
Depreciation	Most farm assets—five years, 150% declining balance method. No indexing	Auto, light trucks, and most livestock—five years. Most farm equipment—seven years, 200% declining balance method. No indexing
Expensing	Up to $5,000, increasing to $10,000 in 1990.	Up to $10,000
Capital Gains	Exclusion—60%. Top tax rate 20%	Repealed exclusion. Top tax rate 28%
Land Clearing Costs	Immediate deduction for expenses within restrictions.	Repealed
Health Insurance Costs	Not deductible by the self-employed.	25% of health insurance costs deductible
Spousal Deduction	10% of lesser of earned income of lower earning spouse of $30,000.	Repealed
Itemized Deductions	Personal property taxes, state and local income taxes, real property taxes, and general sales taxes, home and personal property debt interest.	Repealed deductions for state and local taxes, and interest on personal property debt.
Charitable Contributions	Contribution for nonitemizers allowed.	Nonitemized deductions repealed.
Standard Deductions	Joint and surviving spouse, $3,670	$5,000
	Heads of household, $2,480	$4,400
	Single, $2,480	$3,000
	Married filing separate, $1,835	$2,500
Phase out 15% rate and personal exemption	No provision	Phase-out benefit of 15% rate and personal exemption beginning at $71,900 for joint returns and surviving spouses, $61,650 for heads of households, $35,950 for married filing separately, and $43,150 for individuals.

of less significance to farm proprietors are excluded from the analysis.[3]

Tax rules in effect between 1982 and 1985 differed slightly from the 1986 provisions used to represent the pre-TRA of 1986 provisions in the analysis. Changes incorporated into the model include the marginal tax rate schedules that in general differed in 1982 from pre-TRA of 1986 rates, a doubling in the percentage allowed for deduction by working married couples in 1983, and the modifications to income-averaging provisions.

Estimating Tax Progressivity

A main objective in tax design is equity. Equity in public finance often is defined by the ability-to-pay principle. That principle maintains that taxpayers should contribute to government expenses according to their ability to pay. The concept of vertical equity in the ability-to-pay literature is appropriate for conceptualizing tax progressivity issues. Vertical equity holds that individuals with different means should not pay the same tax.

Using those concepts to determine the progressivity of a tax system requires some quantitative measure of taxpayer ability to pay. Three approaches are used for this analysis. The first part of the analysis computes average effective tax rates for various income classes.[4] A tax system wherein tax rates rise with income is considered progressive. In addition, Lorenz curves are developed, along with Suits aggregate indices of progressivity.

In order to evaluate progressivity, it is necessary to define the income and tax burden measures. In this paper, the tax burden measure that was chosen is the combined federal and self-employment tax.

[3]The alternative minimum tax (AMT) for example, was excluded from the analysis. Even though TRA strengthened the AMT, the elimination of the capital gains preference should have the effect of minimizing the impact of changes in the AMT on farm sole proprietors. Changes in passive loss restrictions and cash accounting rules were excluded from the analysis given difficulties in the data in identifying their importance to tax liability.

[4]Average effective tax rates are defined as tax liability divided by expanded adjusted gross income.

The self-employment tax is assessed and collected as an integral part of the federal income tax for farm sole proprietors. Although it is not a true tax in that future benefits are expected in return for tax payments, modifications to farm income tax provisions can affect both income and self-employment tax bases. Because our primary objective is to compare the progressivity of alternative tax structures, the combined tax burden measure allows for a more complete comparison.

An accurate measure of true economic income is also required to estimate the degree of progressivity. For purposes of this analysis, expanded income is defined as adjusted gross income plus the deduction for married couples when both work, accelerated depreciation in excess of straight line, and the capital gains exclusion. Because items that are not included in adjusted gross income or that provide a tax deduction without an actual expenditure are included in expanded income, expanded income is a better measure of the ability to pay than adjusted gross income. The tax simulation model was used to calculate expanded income by adding those items to pre-TRA of 1986 adjusted gross income. A description of the items and their effect on expanded income is provided below.

Spousal deduction. Prior to the TRA of 1986, 10 percent of the lower-income spouse's earnings up to $3,000 could be excluded from income. For purposes of expanded income that amount was added back into adjusted gross income. This amounted to a total increase of only about $253 million on 1982 proprietor returns. Approximately one in four farm sole proprietors claimed the spousal deduction with $360 the average amount claimed in 1982.

Capital gains. Prior to the TRA of 1986 only 40 percent of long-term capital gains were taxable. Adding the excluded amount to adjusted gross income increased expanded income by $7.836 billion. A large portion of that amount was concentrated in the highest economic income class with an average of almost $360,000 per return (Table 2).

Table 2. Average Capital Gain Exclusion and Accelerated Depreciation Deduction

Expanded Income	Capital Gain Exclusion	Accelerated Depreciation Deduction	Total
$0–$10,000	$308	$969	$1,277
10,000–20,000	403	1,769	2,172
20,000–30,000	582	2,295	2,877
30,000–40,000	842	2,706	3,548
40,000–50,000	1,062	3,248	4,310
50,000–75,000	2,337	3,929	6,266
75,000–100,000	5,175	4,458	9,633
100,000–250,000	13,923	5,507	19,430
250,000–500,000	50,774	8,291	59,065
Over 500,000	359,824	14,676	374,500

Accelerated depreciation. Prior to the TRA of 1986, the Accelerated Cost Recovery System (ACRS) enacted in 1981 had allowed depreciable assets to be written off at accelerated rates over periods of three to nineteen years, depending upon the type of asset. Most farm assets could be written off over five years. Depreciation deductions were based on a 150 percent declining balance method. Each taxpayer could also immediately deduct up to $5,000 of investment each year.

Under current law, depreciation rates are more accelerated. However, recovery periods are longer. Most farm assets can now be written off over a seven-year period. The option to expense up to $5,000 was increased to $10,000. In order to estimate economic depreciation, service lives of machinery and buildings were estimated at ten and twenty-five years, respectively. Those economic lives are consistent with asset lives utilized in similar studies. Economic depreciation was calculated using a straight-line rate over the estimated useful lives. Excess accelerated depreciation was calculated as the difference between the computed economic depreciation and the depreciation deduction, including expensing, actually claimed on the tax return.

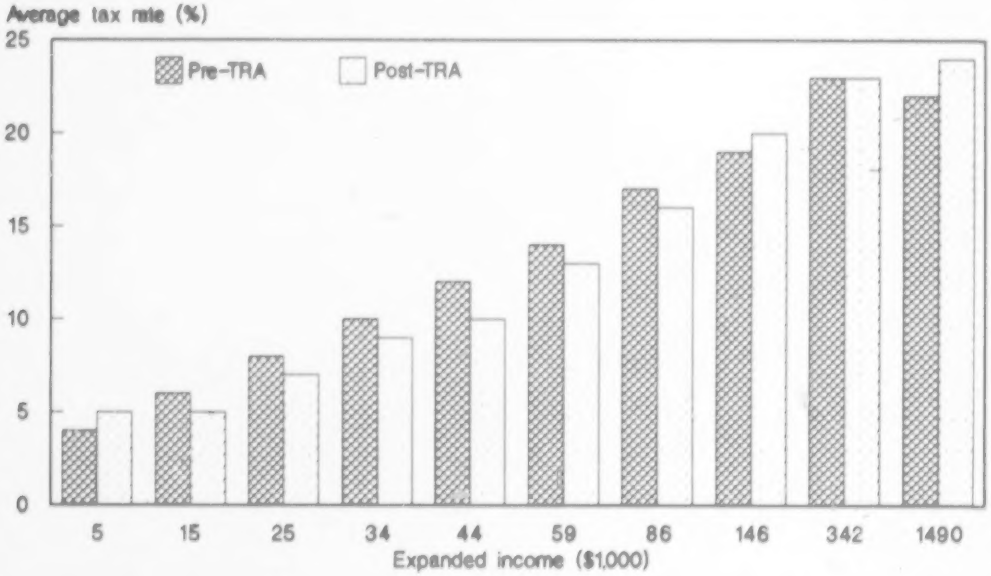
In total, accelerated depreciation in excess of straight-line depreciation was estimated at $6.160 billion in 1982. An examination of average accelerated depreciation deductions for ten expanded income classes (Table 2) reveals that while accelerated depreciation is significantly higher for the highest expanded income class, accelerated depreciation deductions are much more evenly distributed than the capital gains exclusion. Average accelerated depreciation ranged from a low of $969 per return for the lowest expanded income class to $14,676 per return for the top expanded income class.

Estimates of Tax Progressivity

Effective tax rates. Prior to the TRA of 1986, average proprietor tax rates ranged from 4 to 23 percent among the various income classes. With one exception, the higher the expanded income, the greater the average tax rate. However, for farmers with expanded income above $500,000 the average tax rate actually declined. The decline is consistent with similar estimates of average tax rates for all taxpayers (Office of the President). One explanation for the decline is the higher proportion of favorably treated capital gains income for such taxpayers. Those farmers may also have been better able to utilize other tax deductions and credits to lower their tax burdens.

Following the TRA of 1986, average tax rates ranged from 5 to 24 percent (Figure 1). Rates were consistently higher as expanded income increased. Average tax rates were lower for six of the expanded income categories, the same for one and higher for three. One of the categories for which average tax rates increased was the lowest expanded income class (expanded income less than $10,000). That result is inconsistent with similar estimates for all taxpayers, which suggests that taxpayers in the lowest income classes received the largest tax reductions (Office of the President). However, a number of factors

Figure 1. Average Tax Rates: Pre- and Post-TRA



could explain the result. First, our estimates include the self-employment tax. Second, while lower-income farmers benefited from increased personal exemptions and standard deductions, they received little or no relief from marginal tax rate reductions.[5] Third, because TRA of 1986 lowered personal taxes but increased business taxes, farm taxpayers unlike taxpayers in general shared in the higher business taxes primarily through the loss of the investment tax credit and other investment incentives. Despite the sharp reductions in marginal tax rates for high-income taxpayers, average tax rates also increased for the class of taxpayers with expanded income above $500,000. The primary reason for the increase was the elimination of the capital gains exclusion.

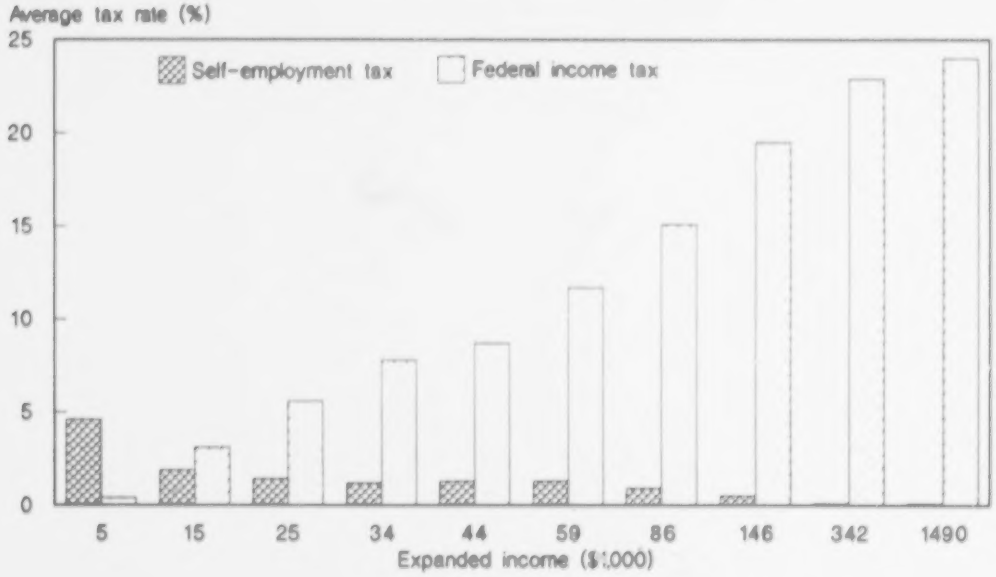
Figure 2 provides a breakdown of average tax rates after tax reform for both the federal income tax and the self-employment tax. As expected, the two taxes have much different effects over a range of incomes. Clearly, the federal income tax shows a steady increase in rates as expanded income increases. By contrast, the self-employment tax shows a definite decline as income increases.

Lorenz curve analysis. Plotting the accumulated percentage of population (ranked from those with the lowest to the highest income) against cumulative total tax liability results in the Lorenz curve (*AA'B*) in Figure 3, providing a visual comparison of progressivity of different tax structures. If all individuals face the same average tax rate, or tax burdens are equal across incomes, then the Lorenz curve coincides with the 45° line. Under a progressive tax system, the greater the inequality of tax burden, the more the Lorenz curve sags downward from the diagonal.

Tax liability was accumulated over the ten expanded income categories. From Figure 4 some general observations comparing tax progressivity for pre- and post-TRA of 1986 provisions can be offered. Note that the gap between the curves widens as the cumulative percent of the population and tax liability rises and then narrows toward the top of the curves. This indicates that tax progressivity is more pronounced around the 85th percentile of income as important tax preferences are taken from the higher-income taxpayers relative to lower-income taxpayers. The Lorenz curves

[5]Changes in marginal tax rates were slight between pre- and post-TRA of 1986 law for lower-income taxpayers.

Figure 2. Average Tax Rates: TRA, Self-Employment Tax, and Federal Income Tax



over segment *OA* indicate that TRA of 1986 is about as progressive as pre-TRA of 1986 law. Taxpayers with incomes less than $10,000, while not losing much in the way of tax credits and capital gains, were less likely to have benefited from lower tax rates than higher-income taxpayers given their income levels. That may explain the intersection of the Lorenz curves. Unfortunately, it is not possible to determine from the figure whether TRA of 1986 is generally more progressive than pre-TRA of 1986 law.

An aggregate measure of progressivity. However, an aggregate index of tax

Figure 3. Lorenz Curve

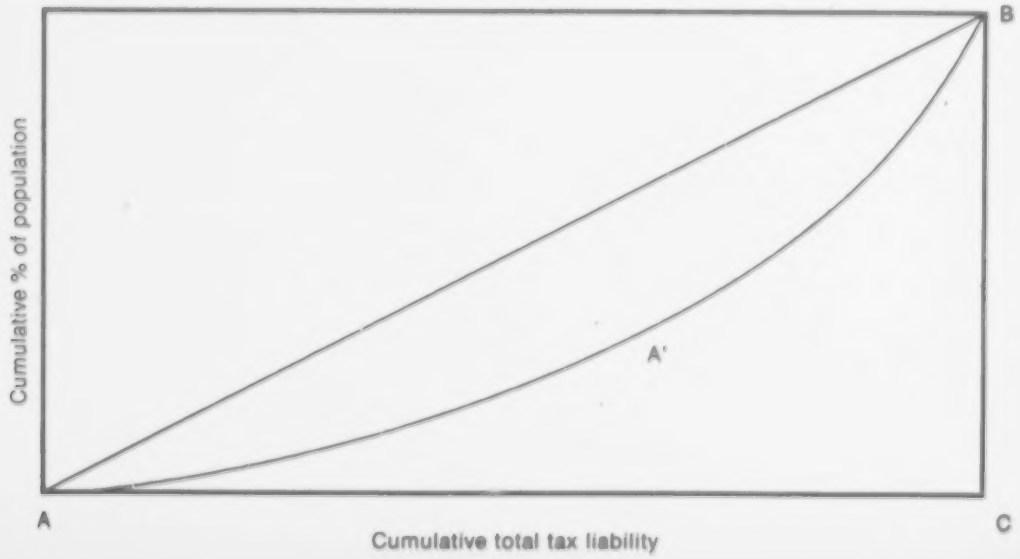
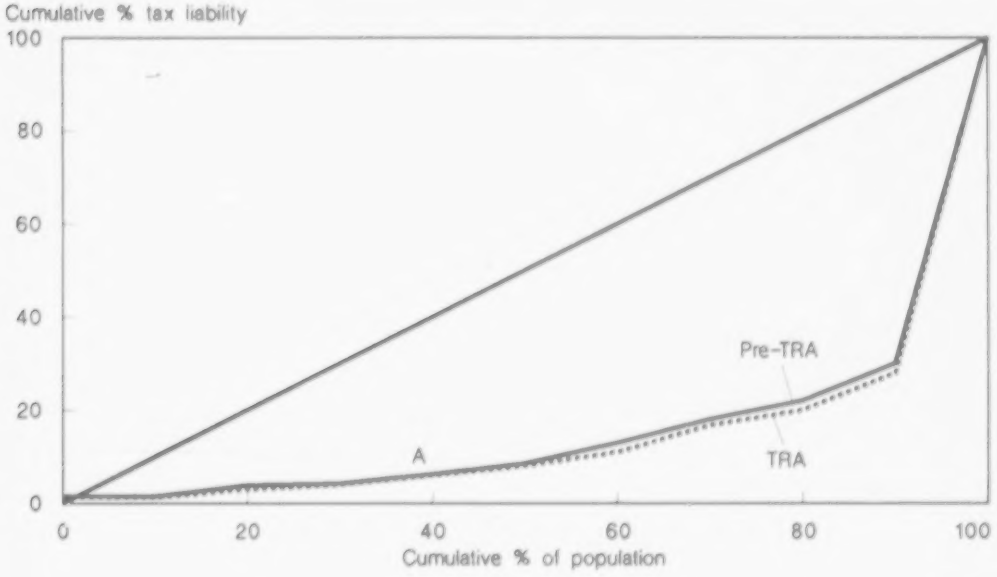


Figure 4. Lorenz Curves Comparing Pre-TRA and TRA Tax Law



progressivity developed by Suits provides such a measure. The index is defined in terms of the areas beneath the diagonal and Lorenz curves; that is, from Figure 3 the index is defined as the following:

$$I = 1 - (AA'BC/ABC) \tag{1}$$

The index equals 0 for a proportional tax; that is, when the Lorenz curve coincides with the diagonal. Alternatively, when the highest income bracket pays the entire tax, then the index equals 1. Because the area under the Lorenz curve is smaller than the area under the diagonal, the index is positive for progressive taxes, and can never exceed 1. For regressive taxes, the index is bounded by 0 and −1. Suits expressed mathematically the area under the Lorenz curve as the following:

$$L_x = \int_0^{100} T_x(y)dy \tag{2}$$

where y is the accumulated percent of income, ranging from 0 to 100, and the accumulated percent of total tax burden for tax x is $T_x(y)$. A close approximation of L_x used for this analysis is represented below as

$$L_x = \sum_{i=1}^{10} (.5)\{T_x(y_i) + T_x(y_{i-1})\}(y_i - y_{i-1}) \tag{3}$$

where y_i represents the ith cumulative income decile. The aggregate measure of progressivity (L_x) for the pre-TRA of 1986 law was computed to be .255. By contrast, the measure was .295 for TRA of 1986 law, indicating that despite the sharp reductions in marginal tax rates, tax reform is slightly more progressive than pre-TRA of 1986 law.[6]

Measures of Tax Progressivity After Reintroducing Capital Gains

Repeal of the capital gains exclusion increased the top tax rate for capital gains from 20 percent to 33 percent. That increase has prompted a number of proposals to restore preferential tax treatment for capital gains income. To

[6]Bear in mind that the index measures average progressivity across various income classes, so a tax could be progressive over one range of incomes and regressive over another.

examine the effect of such proposals on progressivity, the impact of restoring the full prereform exclusion of 60 percent was examined. Reintroducing the exclusion in combination with the relatively low marginal tax rates that exist following TRA of 1986 results in a top tax rate on capital gains of about 13 percent. The effect on average tax rates is substantial. Average tax rates range from 5 to only 17 percent (Figure 5). Tax rates for the three lowest expanded income groups remain unchanged. However, for the three highest expanded income groups, rates were reduced from 25 to 40 percent. In addition, average tax rates are actually the highest for the $250,000 to $500,000 expanded income group. Average tax rates for the highest expanded income class fall sharply. This is similar to the pattern that existed prior to TRA of 1986.

Figure 6 compares Lorenz curves for TRA of 1986 law with TRA of 1986 provisions modified to include the capital gains exclusion. Unlike the pre-TRA of 1986 and TRA of 1986 curves, the Lorenz curves do not intersect. Therefore, reintroduction of the capital gains preference is less progressive than TRA of 1986 throughout the income range. Specifically, the aggregate progressivity index for the tax scenario reinstituting capital gains equals .217 in contrast to .295 under TRA of 1986. The difference (.08) between the values of the indexes for the above two tax scenarios is twice as large as that between TRA of 1986 and pre-TRA of 1986 law (.04). Thus, it is quite clear that restoring the prereform capital gains exclusion with the current tax rate structure would greatly reduce the effective progressivity of the personal federal income and self-employment taxes for farm sole proprietors.

Summary

In this paper, the progressivity of the personal federal income and self-employment tax structures both before and after the enactment of the TRA of 1986 was examined. The impact of restoring the prereform capital gains exclusion was also explored.

The results suggest that prior to the enactment of the TRA of 1986, the tax system was somewhat progressive but that average tax rates peaked and actually declined for the highest expanded income levels. Following tax reform, average tax rates continued to rise with expanded income. Thus, despite the sharp reductions in marginal tax rates for higher-income

Figure 5. Average Tax Rates: With and Without Capital Gains

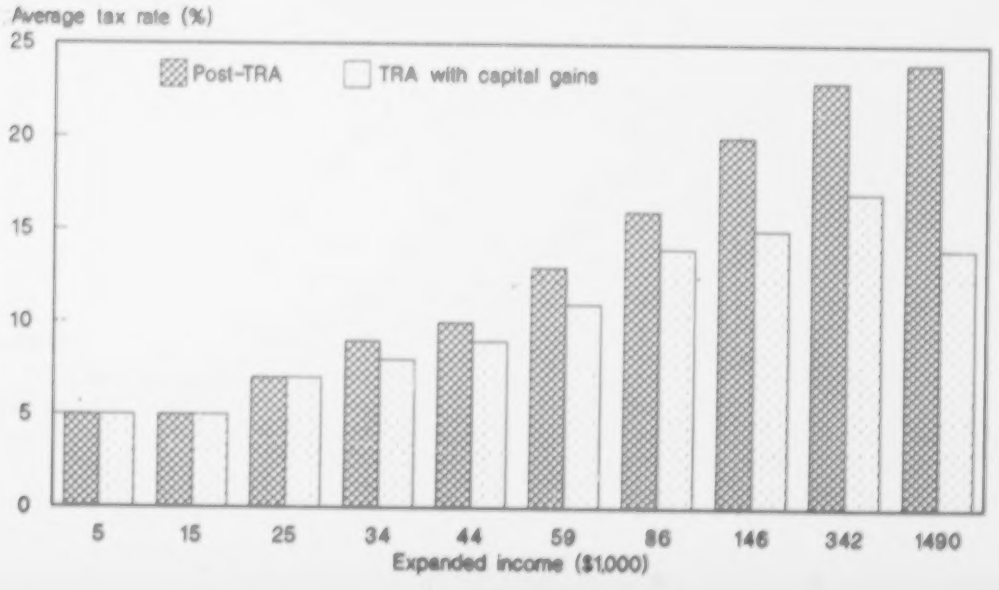
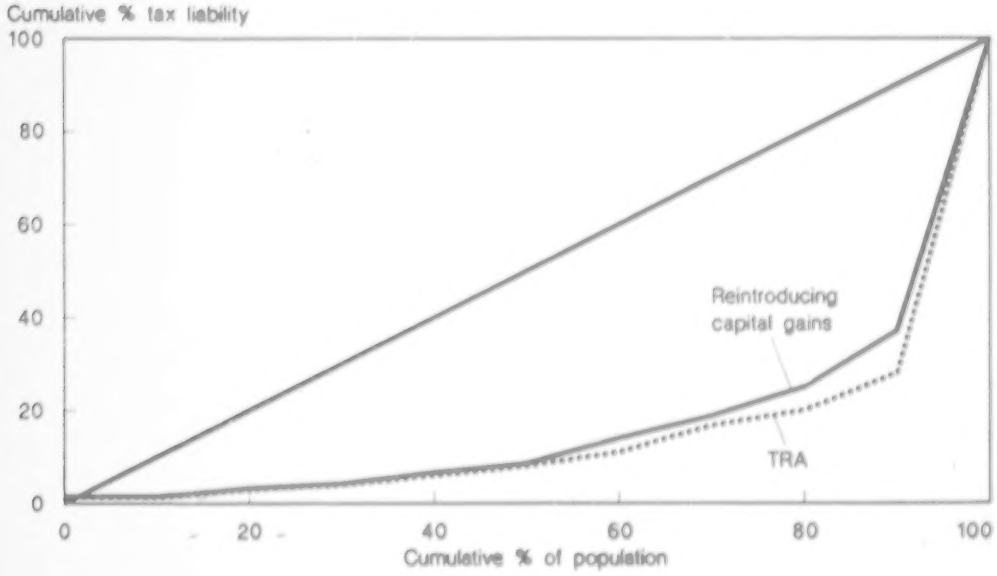


Figure 6. Lorenz Curves Comparing Reintroduction of Capital Gains and TRA



taxpayers, the effective progressivity of the federal income and self-employment taxes actually increased as a result of the base-broadening provisions. To the extent that a progressive tax system suggests fairness, it is reasonable to conclude that the TRA of 1986 at least partially met the objective of improving the fairness of the personal federal income tax system.

Results indicate that restoring preferential treatment for capital gains had a dramatic effect on progressivity. Average tax rates declined for the highest expanded income classes with little or no change at the lower levels. The average tax rate range narrowed significantly with a top average tax rate of only 17 percent. The results suggest that restoring the full prereform capital gains exclusion under the current tax rate structure would reduce the progressivity of the federal income and self-employment taxes and reverse the gains in progressivity achieved as a result of the TRA of 1986.

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Nonfarm Equity Capital Financing of Production Agriculture

J. Lowenberg-DeBoer, Allen M. Featherstone, and David J. Leatham

Abstract

The continued, high real cost of debt and the uncertain future of government programs have increased the attractiveness of financing farm businesses with equity from nonfarm sources. However, the transactions cost and distortion of management incentives in equity sharing arrangements create doubts about the economic viability of such investments. The benefits and costs of alternative equity arrangements are not well documented. This manuscript reviews the base of knowledge dealing with nonfarm equity use in agriculture and suggests future research needs. Researchable topics include: feasible institutions, transactions costs, liquidity, diversification, principal agent problem, monitoring costs, nonprice considerations, and rights of farm tenants.

Key words: nonfarm equity, tenure, financial institutions, transactions costs.

Financing farm firms with outside equity instead of debt has the potential for transferring risk and increasing capital availability, but it may also increase transactions costs and distort management incentives. Equity capital is different from debt primarily in the way it is compensated. Equity investors receive a share of the returns, whereas lenders receive a fixed payment. Servicing a fixed financial commitment from a variable cash flow creates financial risk. If returns to the farm business are low, the compensation for the equity investors is reduced correspondingly. Thus, financial risk is reduced with equity investment. The equity investor may be willing to provide more capital in riskier situations than a lender due to the opportunity to share profits when returns are higher. However, equity investment may require higher monitoring costs than lending due to return sharing. Also, because the farm operator shares ownership in the farm business with the equity investor, the operator may have less incentive to maximize returns to the firm.

This article outlines the current state of knowledge about nonfarm equity use in the U.S. and suggests research directions. The current state of knowledge is explored in three areas: (*a*) the demand for nonfarm equity, (*b*) the potential supply of nonfarm equity, and (*c*) alternative institutional forms for equity investments. This article focuses on profit-motivated, nonfarm equity investment. An ample literature already exists on tax-related equity investment in agriculture (for example, Davenport et al.). The general discussion dealing with the choice of organization for farm businesses is omitted (see Harl or Barry et al.). This article will be of interest to researchers in agricultural finance, to administrators who are responsible for allocating funds to researchers, and to policy makers seeking to avert future farm financial problems.

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At least three reasons exist for expecting farmers to seek alternatives to debt finance in the late 1980s and beyond. The farm financial problems of the early 1980s have revealed the weaknesses of debt finance. Those problems affected primarily farmers with high debt loads (Melichar). The real cost of debt for farmers can be expected to remain high. That is because federal credit subsidies for farmers are being reduced, lenders are aware of the federal deficit and are wary of a new burst of inflation, lenders also recognize the risk in lending to agriculture, and new legislation—such as Chapter 12 Bankruptcy—and mandatory mediation in some states raise lender costs. For example two elements increase the cost of debt: explicit credit subsidies, such as the below-market interest rates on some Farmers Home Administration (FmHA) loans, that are being switched to guaranteed loans at market interest rates and changes in Farm Credit System (FCS) operating procedure that require higher down payment levels. Changes in federal farm programs may reduce the willingness of farmers to use debt. The risk-balancing hypothesis of Gabriel and Baker suggested that farmers are willing to bear a certain level of risk, regardless of its source. Thus, if a government program is cut and production and price risk increase, many farmers will respond by reducing debt, thereby decreasing financial risk (Collins 1985b).

The primary sources of capital in U.S. agriculture have traditionally been operator equity and debt, but the use of nonfarm equity is not new. Joint stock companies were used to finance agricultural development with projects ranging from tobacco production in the Jamestown colony to ranching on the Great Plains (for example, Atherton or Gressley). Initially, much of the external equity capital was European, but as agriculture developed in an area, local nonfarm investors, professional people, and merchants became more involved in supplying capital (Tostlebe; Hibbard and Robotka). Contrary to the popular belief that farm owners settled the frontier, many settlers rented farm land (Winters; Swierenga; Cogswell; Gates). Nonfarm ownership of farm land leased to operators has traditionally been the most common form of equity investment in agriculture. Often, the land is acquired from estate transfer to nonfarm heirs. Currently, about 40 percent of U.S. farm land is rented (U.S. Dept. of Commerce 1984). Limited partnerships have been used in financing specialized farming such as cattle feeding, citrus orchards, and nut groves (Moore; Scofield; Barry et al.). A few farming operations have used sales of common stock to raise equity capital, but high flotation costs have made that route impractical for most farmers (Barry et al.; Penson and Duncan).

Lower farm asset prices in the mid-1980s have sparked some renewed investor interest in farm property (Pelzer). Several equity-type arrangements are beginning to appear in agriculture. Chambers Investment Management has put together ten partnerships in $20,000 units ranging from $1.5 to $4.2 million (Thompson). The farmer becomes a comanaging partner with Chambers, and income is distributed on a seventy-thirty basis, with the largest share going to the limited partner. Other firms such as Metropolitan Life, B.C. Christopher, and Westchester Group have put together farm land limited partnerships ranging from $600,000 to $50 million (Cochran).

Demand for Nonfarm Equity Capital

The demand for nonfarm equity capital is not evident at the sector level, but it appears to be concentrated among certain farm groups. Debt-to-asset (D/A) ratio estimates for the farm sector (for example, 21.8 percent in 1987, U.S. Department of Agriculture) are relatively low compared with those for nonfarm sectors, but they are not directly comparable. The farm sector estimates use the market value of assets, whereas most other sectors use the cost basis value of assets. Dun and Bradstreet report D/A ratios for small groups of relatively large farms that are substantially higher than the U.S. Department of Agriculture (USDA) estimates, but that are within the range of other sectors (Table 1). Other evidence suggests that the farm sector has been a net supplier of equity to other parts of the economy. Penson found that off-farm equity investment by farmers for 1970–75 was positive. Other researchers

Table 1. Debt-to-Asset Ratios and Other Financial Measures for Agricultural and Nonagricultural Industries

Industry	Number Observations	Median Net Worth	Median Sales	Median Debt-To-Assets
Agriculture				
Wheat	98	$859,000	$344,000	0.37
Corn	119	970,000	457,000	0.41
Cotton	72	1,477,000	851,000	0.36
Citrus	77	1,259,000	1,253,000	0.25
Beef Feedlots	136	2,215,000	5,419,000	0.57
Hogs	79	729,000	650,000	0.51
Dairy	178	943,000	600,000	0.39
Eggs	93	1,203,000	2,889,000	0.51
Other Sectors				
Coal Mining	249	$2,326,000	$4,250,000	0.45
Residential Construction	886	540,000	1,215,000	0.51
Passenger Car Rental	612	863,000	715,000	0.69
TV Broadcasting	112	4,898,000	3,483,000	0.37
Cotton Textiles	124	511,000	1,118,000	0.45
Steel Foundries	45	1,259,000	2,397,000	0.53
Aircraft	35	2,551,000	4,973,000	0.53
Grocery Stores	2,295	313,000	1,400,000	0.46
Metal Cans	29	3,977,000	5,000,000	0.61

Source: Dun and Bradstreet Credit Services, *Industry Norms and Key Business Ratios, One Year, 1986-87 Edition*, 1986.

(McKinzie et al.) also found a net equity outflow from the farm sector.

U.S. farms that are profitable and that have high debt would likely benefit from equity investment. About 12 percent of farms had positive cash flows and D/A ratios over 40 percent in early 1987 (Table 2). That group accounts for 42 percent, or $41.4 billion, of farm debt. The immediate benefit of nonfarm equity for the group would be risk reduction. Profitable lower-debt farms might benefit from nonfarm equity investment, but that benefit would be more long term. Nonfarm equity capital could help finance new or expanding firms without the major financial risk that occurs with debt finance. The additional equity capital could help farmers take advantage of economies of scale or adopt new technology. Farmers could diversify their investment portfolio by acquiring nonfarm equity to finance the farm business, thereby allowing use of some of their own equity to purchase assets in other sectors.

The research framework for analyzing equity use in farm businesses is not well developed. Some agricultural finance textbooks assume that the costs of acquiring both debt and equity rise as leverage increases and that there is some combination of debt and equity that minimizes the cost of capital (Barry et al.; Penson and Lins). Others discuss the relative risks of various capital sources and state that capital structure is a subjective decision based primarily on risk attitude (Lee et al.). Empirical estimates of the optimal farm capital structure within this

Table 2. U.S. Farms and Farm Debt by Debt-to-Asset Ratio for Farms with Positive Cash Income

D/A	Number Farms	Percent Farms	Percent Debt	Total Debt
	(1,000)			(billion)
0	300	19.9%	0.0%	$ 0.0
0.01–0.1	129	8.6	2.8	2.8
0.11–0.4	194	12.9	18.8	18.5
0.41–0.7	106	7.0	20.9	20.6
0.71–1.0	42	2.8	13.0	12.8
>1.0	29	1.9	8.1	8.0

Source: *Financial Characteristics of U.S. Farms*, Jan. 1, 1987, Economic Research Service, U.S. Department of Agriculture.

framework are almost entirely lacking. Instead, textbook rules of thumb identify 50 to 60 percent D/A ratios as a critical point (Lee et al.). Higher D/A ratios are said to be feasible with good management but very risky.

Most empirical work in agricultural economics assumes that equity is fixed or grows through retained earnings. Firm growth studies have allowed farm equity to be augmented out of retained farm and nonfarm earnings (Boehlje and White; Richardson and Condra). Other studies—especially firm survival work using simulation models—fixed farm physical size and varied debt and leasing combinations, thereby explicitly or implicitly varying equity (Richardson et al.; Richardson and Condra; Hinman and Hutton; Held and Helmers). Generalization about equity either from growth or survival studies is difficult due to the location-specific nature of the models and the informal nature of their theoretical foundations.

More complete models of capital structure choice have been developed but have not been tested empirically. Collins and Bourn use a mean variance model to derive farmers' reservation prices for nonfarm equity. They show that, in some cases, farmers are willing to pay more than a proportionate share of income to nonfarm equity investors. Other models that choose optimal financial structure and could be used to address the demand for equity include models that maximize expected present value of consumption over time (Collins 1985a), that maximize expected wealth in a dynamic environment with uncertain real estate prices using a modified Vickers model (Lowenberg-DeBoer), and that maximize expected utility in a dynamic and risky environment using discrete stochastic programming (Featherstone and Baker). None of the above models differentiates explicitly between farm and nonfarm equity, although they could be modified to address the optimal choice of farm and nonfarm equity.

The capital structure debate in the general finance literature is of little help in solving the farm equity problem. The financial structure debate in the general finance literature has focused on corporate firms with publicly traded stock. Most farm firms are sole proprietorships or partnerships, and those organized as corporations are usually closely held by family groups.

At best, the available evidence leads to rough estimates of the upper boundary for nonfarm equity demand. The work of Collins and Bourn suggested that farmers would be willing to replace some debt with equity, especially in highly leveraged farm operations. According to USDA estimates, total agricultural debt in the U.S. in 1986 was $157 billion. Only a portion of that would be converted to equity. At least initially, highly leveraged farmers would be the most likely to participate in nonfarm equity arrangements. Investor interest is likely to be limited to profitable farms. Assuming that farmers would not reduce debt below 50 percent of assets and based on the $41 billion of debt held by profitable, highly leveraged farmers, the initial demand for nonfarm equity might be roughly $20.5 billion.[1] The demand could be higher in the long run, if total demand for capital expands or lower leverage appears to be beneficial. Once a nonfarm equity market is functioning, the amount demanded does not appear to be a burden for U.S. financial markets. The amount is small in comparison with the total size of all financial markets; for example, the value of all shares on the New York Stock Exchange in 1985 was $1,950 billion (U.S. Department of Commerce 1986).

Supply of Nonfarm Equity

If institutional arrangements can be developed to facilitate nonfarm equity investment, the supply of investor funds will depend on risk and return characteristics of farm investment. Raup posed the question, "Why would outside investors want to assume some of the risks of contemporary farming?" If there is no incentive for investment, nonfarm equity capital financing for production agriculture will never become important.

[1]The estimate of $20.5 billion is only a ballpark figure. Some farms that are currently unprofitable in the USDA classification might be profitable if nonfarm equity were available. Thus, the estimate may be conservative.

The attractiveness of farm investments for nonfarmers has been approached in the agricultural economics literature largely in the context of the Capital Asset Pricing Model (CAPM) or similar models. No one model completely describes investor behavior, but mean variance models, such as the CAPM, are widely used by investment bankers and investors to analyze risk and return relationships. Using budgeted returns for farm land in various geographic regions and the CAPM, Barry found that farm land investment has little systematic risk for the nonfarm investor. Systematic risk is the variability that cannot be diversified away. The CAPM assumes that in equilibrium, investors would require compensation only for systematic risk, because nonsystematic risk could be diversified away. Barry's results indicated that direct investment in farm land "is a promising candidate for risk reduction in well-diversified portfolios." Irwin et al. recently updated Barry's study and found that farm real estate is not highly correlated to the performance of a market portfolio.

Similarly, Ibbotson and Fall and Kaplan found that farm real estate has a low level of systematic risk in a well-diversified portfolio. Other studies suggested that in the long term, farm land returns have been comparable with those of common stock (Gertel and Lewis; Kost; Hottel and Gardner; and Moss et al.).

Collins and Bourn, using returns to publicly traded firms with large agricultural interests, found that farm investments have a systematic risk level approximately equal to that of the general economy. Due to that relatively high level of systematic risk, Collins and Bourn concluded that if farm returns are near historical averages, then nonfarm investors would require about 1.75 percent of the returns for each percent of the assets contributed. They also showed that some highly leveraged or risk-averse farmers may be willing to agree to more than a proportional sharing of profits in exchange for risk reduction. It is not clear whether the difference between CAPM results of Barry and Collins and Bourn was due to the different types of farming represented. The firms used by Collins and Bourn were primarily involved in specialized production, such as fruits and vegetables. The aggregate data used by Barry, Kaplan, and Ibbotson and Fall included many general farming operations producing bulk commodities. Another possibility is that public trading introduces systematic risk. However, the above studies showed that some plausible conditions exist under which nonfarm investors might make equity investments in agriculture.

The investor interested in farm equity is probably the same investor who is interested in common stock, the basic equity investment in the nonfarm sector. Farm real estate offers the possibility of substantial capital gains and losses; thus, as in the stock market, profitability depends a great deal on timing of sales and purchases. Investors supplying nonfarm equity are probably not the same investors who currently buy FCS bonds. The risk and return relationship for the equity investment is much higher than that for bonds, because FCS bonds enjoy a privileged legal status that would not be shared by the equity investment. The FCS bonds are in many ways equivalent to Treasury securities, and in many states, banks can meet reserve requirements with FCS bonds.

Alternative Institutional Forms

Institutional conditions may be major contraints to nonfarm equity investment in agriculture. Many states have legal restrictions on farm investment by nonfarmers (Pelzer). Land ownership by corporations is restricted in ten states. Investment by nonresident aliens[2] is limited or prohibited in thirty states. In addition to the legal constraints, the lack of appropriate market institutions may limit nonfarm equity investment in agriculture. Existing market mechanisms, such as selling shares of common stock or limited partnerships, involve relatively high transactions costs, even for large-scale commercial farms.

Fiske, Batte, and Lee and Matthews and Harrington identified several institutional arrangements for equity financing of agriculture. Institutional forms currently

[2]Nonresident aliens are persons living outside of the U.S. who are not U.S. citizens.

used or suggested for nonfarm equity investment in agriculture fall into three categories: (*a*) direct, personal ownership of farm assets, (*b*) partnerships, and (*c*) direct ownership of farm assets by a corporation. Direct, personal ownership of farm assets by nonfarmers is at present the most common method. Usually, the asset owned is land, but nonland assets may be owned as well. The demand by farmers for rental land is strong, but rental arrangements differ widely. Some nonfarm investors lease farm assets to farm operators for a fixed cash payment and take a minimal part in management of the assets. Share arrangements, with the nonfarm investor paying part of the production expenses and taking part of the output, are common. A few nonfarm investors hire farmers to perform production activities, while they retain all management functions. A large and well-organized professional farm management industry exists to oversee nonfarm investor property. Management fees vary by region and type of farm, but 10 percent of gross income is common ("An Inside Look at Farm Management Fees").

For an urban investor with no farm background, the problem of finding and buying appropriate farm property may involve substantial search and information costs. Many nonfarmers who own farm property are nonfarm heirs of farm families, have farm backgrounds, or live in farming areas (Reiss). For those individuals, the search and information costs are probably modest. Some farm management firms offer professional help in locating and buying farm investment property. The cost of selling farm real estate involves broker's fees of 3 to 7 percent, as well as fees for surveying and documentation. Selling farm real estate is usually a slow process because each tract of land is unique. Quick sales are possible, but they usually require cutting the price substantially below market levels. In the U.S., there are few legal restrictions on the ownership of farm property by individual citizens or resident aliens. Because farm assets come in rather large, discrete units, diversification with direct ownership of farm assets may be difficult for the small investor.

Numerous partnership arrangements are possible. The three major alternatives for the nonfarm investor are: unlimited partnership; direct, personal ownership of a limited partnership; and indirect limited partnerships held by a corporation or another partnership. The partnership differs from direct asset ownership, in that the partner owns part of the farm business, not just the farm assets. Partnerships between farmers and nonfarmers are most commonly used in the U.S. for farm operations that involve a substantial nonland component, such as livestock, equipment, or specialized management. In an unlimited partnership, the partner participates in management of the farm and is fully liable for all partnership losses, even those beyond the original investment. Thus, the unlimited partnership is probably appropriate only for the individual who has substantial management expertise to contribute to the enterprise and lives in the locality.

Most nonfarm equity investors would probably prefer the limited partnership, because the limited partner's liability is restricted to the original investment. Limited partnerships have been used to facilitate investment in cattle feeding, citrus groves, nut orchards, and other specialized farm ventures (Matthews and Rhodes). Direct, personal investment in either limited or unlimited farm partnerships shares many of the problems of direct ownership of farm real estate. Finding a farmer who has a profitable operation and who wants an outside partner is no trivial task. In addition, negotiating the partnership agreement is likely to be complex because every farm operation is in some ways unique. Because standardization is difficult, the directly owned partnership is likely to be an illiquid asset. In some cases, large farming operations have marketed standardized limited partnerships through brokers. That improves the liquidity of the limited partnership, but sales of partnership shares often need to be approved by the general partner. In general, limited partnership shares are available in smaller units than farm assets, so diversification is easier with a partnership than with direct ownership.

If the partnership is owned by a corporation, the shares of the corporation could be publicly traded. A major disadvantage of a corporation holding

partnerships is that the income is taxed twice, first at the corporate level and then at the individual level. Collins and Bourn have suggested that the partnerships be held by a Real Estate Investment Trust (REIT) to avoid double taxation. To qualify as a REIT, the corporation must (*a*) have more than one hundred shareholders with not more than 50 percent of the corporation held by five or fewer individuals; (*b*) keep 75 percent or more of its assets in real estate, mortgages, or cash; (*c*) generate 75 percent or more of its income from real estate holdings; (*d*) have at least 95 percent of its income from rent, interest, or capital gains; and (*e*) distribute at least 95 percent of its income each year (U.S. Department of the Treasury 1986a, 1986b). Collins and Bourn envisioned the REIT holding standardized limited partnership agreements with numerous farmers, probably scattered over a wide geographical area as a diversification measure. An alternative would be for the REIT to hold mortgages in which there is some equity participation, for instance, shared appreciation mortgages. In the limited partnership, the farmer would be the general partner and would exercise all management control. Collins and Bourn suggested that the costs of placing the limited partnership would be from 5 to 15 percent. The administrative costs, including adviser's compensation, trustee fees, legal fees, accounting costs and shareholder costs range from 1.1 to 5.2 percent of net assets, with an average of 2.2 percent in 1985. As the farm REIT gains experience in identifying potential farm partners and negotiating partnership agreements with them, the search and information cost may be reduced because farmers might come to the REIT seeking a partnership. Methods for identifying good managers with sound operations need to be developed. The legal status of the arrangement is not clear. Can a REIT hold limited partnerships? Similarly, the status of such an organization in states that limit corporate ownership of farm property is in question.

Direct corporate ownership of farm assets may take many forms. The corporation could own the assets and lease them to farmers. That was the core of the Ag Land Trust proposal in the mid-1970s (U.S. House of Representatives). Corporations may also take an active role in management. Numerous corporations now own and operate farms. The main advantages of the corporate structure are the limited liability and the liquidity. Transactions costs for direct corporate ownership would depend on the degree of management involvement, but would probably be lower than with a similar degree of management involvement in either personal ownership or partnerships. The broker's fees in buying shares of a publicly traded corporation vary substantially but are commonly in the 0.5 to 2 percent range. Thus, transactions costs for the investor are lower for the publicly traded corporation than the cost of placing a limited partnership or buying farm property. Buying shares would involve contacting a broker, a much simpler procedure than searching for a tract of farm land or a partner. If the corporation rented its property to operating farmers, the management costs should not be more than if a person rended land through a professional farm management firm. In fact, costs may be lower if the corporation can achieve economies of scale or scope that are not available to the farm management firm.

Direct corporate ownership would allow more management flexibility than a REIT. Retained earnings could be used to build equity; a REIT must pay out 95 percent of earnings. The corporation could diversify outside of real estate. Investor diversification with corporate ownership would be easy; shares of the farm corporation could be included along with other investments in a balanced portfolio. Direct corporate ownership as well as a REIT partnership may suffer initially from "start up" problems. It may be difficult for investors to liquidate holdings in the early stages of the market and difficult for the fund to attract capable managers. However, if those types of organizations are able to offer a more efficient means for nonfarm investors to invest in production agriculture, the problems could perhaps be worked around by the timing of the start up. Direct corporate ownership would subject earnings to double taxation. However, the most important problem with direct corporate ownership is political. The Ag Land Trust proposal in the 1970s created a political storm. In some states, the farm financial problems of the early 1980s

reduced opposition to corporate involvement in agriculture; some farmers were ready to sell their assets to anyone who would buy and to work for the highest paying employer, even if that purchaser were a corporation. But in other states (for example, Nebraska), the reaction to farm financial problems has been to blame the corporations.

A qualitative assessment of alternative institutions for nonfarm equity investment in agriculture is summarized in Table 3. Personal ownership has the advantage of already operating markets. It fails in terms of liquidity and perhaps in diversification potential. Direct partnerships have many of the same characteristics as direct asset ownership, but may have higher transaction costs. The REIT partnership does much better than direct ownership in liquidity and diversification potential, but it involves legal and political questions, as well as relatively high transactions costs. The direct corporate ownership alternative offers several advantages, but it appears politically weak.

Research Directions

The previous discussion suggests several specific research topics. The list provided here is by no means exhaustive in terms of possible researchable issues or methods that could be used to address those issues, but it should provide a starting point for examining the desirability of nonfarm equity financing in agriculture.

Alternative institutions. A set of alternative institutions needs to be defined. Current legal restrictions are important in identifying the set, but they are not absolutes. The rules governing farm land ownership and the operations of financial institutions change as the needs of society change and as the public understanding of the costs and benefits of particular institutions change. A broad survey documenting the public view on alternative institutions would be a reasonable way to approach the question. The survey could be done under the auspices of a regional research or extension committee similar to the recent survey on farmer's views on agricultural policy (Guither et al.). The survey sample should be broader than the farm population. Not only farmers, but also landlords, investors, and the nonfarm rural population have a substantial interest in who owns farm property, and how it is financed.

Transactions cost. The search and information costs and the negotiation costs differ substantially between alternative institutions. The costs for farm land rental and direct partnerships are fairly well documented, but it is not clear how the transactions costs of alternative institutions compare with the more traditional equity investments. Research approaches that would quantify the transactions costs of the alternative institutions might include a survey of transactions costs for similar nonfarm investments or a case study of the emerging equity instruments.

Liquidity. Liquidity is an important variable in determining the feasibility of equity investment in agriculture. If new partnership and corporate organizations are to be adopted, they must increase the liquidity of farm assets. It is also important to study

Table 3. Relative Strengths of Nonfarm Equity Institutions

Item	Personal Owner	Direct Partnerships	REIT Partnership	Corporate Partnership
Transaction Costs	high[1]	medium-high	medium	lowest
Risk				
Liquidity	low	low	good	good
Diversify	low	low	good	good
Politically Acceptable	yes	yes	maybe	major problem
Legal	yes	yes	maybe	some states
Information and Search Costs	high[1]	high	medium	lowest
Attractive to Investors	maybe	maybe	maybe	maybe
Attractive to Farmers	yes	maybe	maybe	maybe

[1]May be lower for persons familiar with agriculture.

alternatives for increasing liquidity for an investor in the early stages for new partnership and corporate organizations. Research approaches might include surveys to determine farmer and investor perception of liquidity and liquidity premiums and mathematical programming models with penalties for "wrong choices" (Featherstone and Baker).

Farm equity diversification. Potentially, nonfarm equity investment in agriculture could permit farmers to diversify their equity investments into the nonfarm economy. The extent to which this already occurs and the benefits from increased off-farm investments by farmers are not well understood. Information on current nonfarm equity holdings of farmers might be obtained through USDA's Farm Costs and Returns Survey. Models applying portfolio or asset pricing theory could suggest gains with equity investment changes.

Systematic capital gains and losses. Systematic risk estimates for closely held and publicly traded agricultural investments appear to differ. A better understanding of what happens to risk and return relationships if agricultural investments become publicly traded is important when evaluating nonfarm equity investments. Research approaches include case studies of closely held firms that went public and improved modeling of agricultural investment returns, so as to include discount rate changes and other potential sources of systematic risk related to the public market.

Principal agent problem. Management incentives may differ between the owner-operated farm and the farm with outside equity. Can the equity investment arrangement be tailored to reduce this problem? Methods for studying this problem include econometric analysis of farm record data, along the lines of Ellinger and Barry, to determine whether tenure affects farmer behavior.

Sharing capital gain. Investors and farmers may have preferences as to whether they would like current income or capital gain. Farmers may need current income to alleviate cash flow problems. Long-term investors may be indifferent between cash and capital gain, and they may prefer capital gains when these are given a tax preference. It may be Pareto optimal to unequally share returns, with the investor receiving a greater share of the capital gain and the farmer receiving a greater share of current income. Those benefits could be estimated by modeling farmer and investor behavior using portfolio theory.

Monitoring and metering cost. In certain equity investment arrangements, the farm operator has incentives to deceive the investor. Monitoring (for example, annual audited financial statement) would be needed to avoid investor losses. Monitoring costs can differ substantially between rental arrangements (Alston et al.). Those costs can be estimated from historical data or by case studies. Surveys of professional farm managers also may be useful.

Nonprice considerations. Nonprice terms of equity investment arrangements may be important. How real estate titles are held may affect pride of ownership or social status of farmers. Nonfarm investors may be willing to accept a lower than market return for farm investments because of the mystique of participating in the perceived wholesome farm life. Research methods might include surveys.

Rights of farm tenants. Farm tenure questions are closely related to the issue of nonfarm equity investment because direct ownership of farm land with rental to farmers is one route for nonfarm investment in agriculture. In the U.S., farmers who rent land have relatively few rights to the property compared with operators in many other countries (Seabrooke; Maunder; Peters). Rental agreements are usually for one year with the notice period required for termination being relatively short. The tenant seldom has a legal right to unexhausted improvements. Increased tenant rights in rented farm property may facilitate farmers' investing off the farm, because more farmers may view leasing farm land as a viable option to ownership. Surveys and modeling might be used to identify improvements in the legal structure of tenancy.

Concluding Comments

The farm financial experience of the early 1980s has increased awareness of problems

with debt finance. The continued, high real cost of debt and the uncertain future of government farm programs make equity arrangements more attractive. However, the relatively high transaction cost of equity investment and the possible distortion of management incentives in equity sharing arrangements create doubts about the economic viability of such investments. Comparatively little research is available to help assess the potential and the limitations of nonfarm equity investment. The theoretical foundations for analyzing outside equity investment in proprietary firms are not well developed.

Numerous topics under the category of nonfarm equity finance appear to be researchable, but relatively little empirical research exists. The empirical work that has been done tends to be location specific and hard to generalize. Rigorous analysis of nonfarm equity investment in production agriculture is limited by the lack of basic data on relevant institutional structure, the costs of alternative institutional structures, current investment flows, and available information on the transactions and liquidity costs of various equity instruments.

The logical first step in the investigation of nonfarm equity investment is data gathering. Gathering of transactions costs and other information for currently used institutional structures (for example, farm land rental) can be accomplished with surveys. However, observable information on costs for proposed institutions is not readily available. One method to obtain such information is to perform an experiment. For example, certain investment corporations might be willing to actually underwrite and test market an equity instrument for agriculture but lack expertise in agriculture. With collaboration between agricultural economists and an investment corporation, it might be possible to arrange the test marketing of a nonfarm equity financial instrument. Much insight could be gained from a case study of a functioning institution for nonfarm equity use in production agriculture. Economists often resort to complex behavioral models because of an inability to use economic experiments. The introduction and evaluation of a specific equity instrument on a small-scale basis could complement traditional modeling. Sources of funding, in addition to the usual public sector institutions, might include corporations involved in the underwriting of equity arrangements.

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The Debt Structure Index: An Approach to Evaluating Financial Structure

Michael A. Mazzocco

Abstract

Common ratio analysis does not sufficiently address potential future liquidity issues arising from the timing of liability maturities and rates at which noncurrent assets contribute to cash flow. The debt structure index (DSI) is developed to describe the relative balance between term liabilities and fixed assets. The ratio of term liabilities to fixed assets is shown to be the product of the debt-to-asset (D/A) ratio and the DSI. A sample of Illinois farms is used to generate statistics on the distribution of the DSI and its correlation with other commonly used financial indicators.

Key words: financial analysis, liquidity, ratio analysis.

Financial analysts, lenders, managers, and other users of financial statements often utilize ratio analysis techniques to evaluate the liquidity, solvency, profitability, and efficiency of firms. Different individuals or groups favor various measures of each of those four financial characteristics, depending upon their motivation for analyzing the firm (Van Horne; Weston and Brigham). Within the U.S. agricultural production sector, particular attention has been given to the D/A ratio as a measure of solvency and the current ratio (current assets divided by current liabilities) as a measure of liquidity. Penson pointed to the failure of any one financial indicator to adequately assess the financial health of the farm sector. The same may be said for the financial health of a firm (Van Horne; Frey and Behrens). Although the D/A ratio and the current ratio measure two distinct relationships between assets and liabilities, they do not contain all the relevant information regarding the relative structure of assets and liabilities.[1] Johnson et al. used the D/A ratio to categorize farms likely to experience financial difficulty. Duncan and Harrington also used the D/A ratio to classify farm financial condition, stating that it is "one of the primary factors that determines if the farm will have cash flow difficulties (p. 3)." However, this is only true if either (*a*) the maturity structure of the debt is meaningfully shorter than the time path of expected asset returns or (*b*) interest rates on borrowed funds are high compared with the rate of return on the assets they finance. The latter issue has been and will continue to be examined by both researchers and investors. The relative

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[1]The term *structure* denotes the relative distribution of assets and liabilities into the classifications of current, intermediate, and fixed, or long term.

maturity of assets and liabilities is the subject of this paper.

The concept of measuring correspondence between asset and liability maturities is not new. Financial institutions have long been utilizing gap and duration analysis.[2] However, their analysis focuses on repricing or redeployment opportunities of assets and liabilities and the earnings and equity exposure that may result from a mismatch in maturities. Nonfinancial firms are more concerned with the liquidity effects of mismatching cash flows from assets and required debt repayment. The current ratio may reflect the firm's ability to meet obligations as they arise during the next twelve months. However, it does not address the matching of longer-term cash flows from fixed assets and required term debt repayment beyond that period.

This paper develops a measure of the relative structure of a firm's assets and liabilities. The first section describes the motivation for identifying the relationship. The remaining sections develop the DSI, describe its application in financial analysis and management, and report its distribution and correlation with other financial characteristics for a sample of Illinois farms.

Motivation for Describing Relative Structure of Assets and Liabilities

Financial analysts usually assess (predict) one or more aspects of the present (future) operations or financial condition of a firm. The use of financial ratio analysis for such purposes is well documented (Van Horne; Weston and Brigham; Frey and Behrens; Barry et al.). Lenders constitute a major category of such analysts. In assessing the liquidity and solvency of a firm, the lender is, in part, predicting the ability of the firm to meet its obligations in the near term and the long run, respectively.

The agricultural production sector's increased investment in intermediate and fixed assets during the past few decades has been well documented. Both the nominal value of noncurrent assets and their relative share of all assets within the sector have increased markedly. The U.S. Department of Agriculture (USDA, p. 57) reported that the percentage of farm sector assets held in real estate, machinery, and motor vehicles (excluding operator households) increased from 72.4 percent to 84.1 percent between 1950 and 1987. The drain on the liquidity of the sector resulting from that investment as well as the dedication of future earnings required to repay the associated increase in debt have also been discussed. The USDA estimated that fixed asset turnover (cash receipts from farm marketings of crops, livestock, and livestock products divided by the value of land, buildings, and machinery) declined from .32 in 1950 to .23 in 1987. The shift toward fixed assets resulted in financial assets and crop and livestock inventories declining from 27.6 percent to 15.9 percent of farm sector assets. The shift from liquid to fixed assets was accompanied by a comparatively stable financing structure between real estate and nonreal estate debt. This suggests that fixed assets were acquired with a historically large proportion of short-term debt and cash from current asset liquidation.[3] Those issues may also be addressed at the firm level. Liquidity changes may be analyzed using standard measures referenced above. The capital debt repayment capacity that is required to retire noncurrent debt in an orderly fashion may be calculated to assess the dedication of future earnings. However, the relationship between fixed assets and term debt has not been adequately addressed.[4]

Numerous authors have promoted various methods to analyze the impacts of term debt. Barry et al. referred to the intermediate ratio (intermediate assets divided by intermediate liabilities) and the

[2]See Sinkey or Mitchell for a discussion of gap and duration analysis as used by commercial banks.

[3]Real estate debt was 47.8 percent of farm sector debt in 1950 and 56.6 percent in 1987. This conclusion is limited by the aggregation of debts of all maturities into combined loan purpose/collateral classifications.

[4]As used herein, *fixed assets* refer to both intermediate and long-term assets; *term debt* refers to both intermediate and long-term debt. For a complete discussion of those terms, see any finance or accounting text.

fixed ratio (fixed assets divided by long-term liabilities), indicating those measures describe the percentage of equity accumulated in each asset category. Those measures also indicate the capacity to refinance shorter-term debt into longer-term debt based solely on collateral values. The intermediate and fixed ratios must be analyzed in conjunction with the current ratio to gain a clearer perspective on the relative financial structure of the firm, including the relative allocation of equity within each asset category. Unfortunately, those disjoint measures do not describe the relationship between all noncurrent assets and liabilities and their relative maturities.

In analyses more applicable to corporate finance, Van Horne suggested a ratio of term debt divided by total capitalization (stockholders' equity plus term debt) to describe the importance of term debt in the long-term capitalization of the firm. That ratio is more useful as a leverage measure than as an indication of maturity matching. It is not intended to indicate liquidity problems likely to arise from assets of various remaining useful lives or intended duration being financed by debt of noncorresponding maturities. Weston and Brigham (as well as Brigham) examined some aspects of maturity matching by describing the relationship between (*a*) the sum of permanent current assets plus fixed assets and (*b*) the sum of term debt and equity capital as ranging from aggressive to conservative. However, the future cash flow demands of contractual debt service are not easily aggregated with future residual cash flows to identify potential longer-run liquidity problems.

Some authors describe a debt structure ratio as current liabilities divided by total liabilities (Frey and Behrens; Penson and Lins). That measure indicates the percentage of liabilities that comes due during the next twelve months. However, it does not indicate a firm's ability to meet obligations as they arise. That measure would become more indicative of overall financial structure when compared with the percentage of assets to be converted to cash within the next twelve months to indicate any possible mismatching of current assets and current liabilities.

The Debt Structure Index

To assess the relative balance of asset and liability maturities, the measure used should be both easy to calculate and easy to interpret. The DSI is such a measure and is calculated as

$$DSI = \frac{Term\ Liabilities}{Total\ Liabilities} / \frac{Fixed\ Assets}{Total\ Assets}. \tag{1}$$

This describes the relative balance between (*a*) the percentage of liabilities that are term liabilities and (*b*) the percentage of assets that are fixed assets. The DSI will always fall between zero and infinity by definition. If the percentages of term liabilities and fixed assets are equal, then the ratio is equal to one. If liabilities are more concentrated in term liabilities than assets are concentrated in fixed assets, then the ratio will be greater than one. In contrast, if assets are more concentrated in fixed assets than liabilities are concentrated in term liabilities, then the ratio will be less than one.[5] The use of term (noncurrent) liabilities and fixed (noncurrent) assets in the ratio focuses direct rather than indirect attention on longer-term financial structure and, thus, is intuitively appealing. A higher DSI indicates more long-term liquidity, with everything else remaining equal.

The relationship between the DSI, the D/A ratio, and the ratio of term liabilities to fixed assets can be seen as

$$DSI = \frac{D - CL}{D} / \frac{A - CA}{A}$$
$$= \frac{A}{D} \cdot \frac{D - CL}{A - CA}, \tag{2}$$

where A is total assets, CA is current assets, D is total liabilities, and CL is current

[5]Proportionally, the ratio of current liabilities as a percentage of total liabilities to current assets as a percentage of total assets indicates the same balance or relative timing of cash flows from assets and debt repayment requirements. However, the interpretation of the ratio is inverted (ratio of less than one indicates more liabilities are concentrated in term liabilities than assets are concentrated in fixed assets).

liabilities. Changing the nomenclature slightly, letting fixed assets and term liabilities be indicated by *FA* and *TL* respectively, equation (2) can be rewritten as

$$(D/A) \cdot DSI = TL/FA \qquad (3)$$

Equation (3) indicates that the ratio of term liabilities to fixed assets is a multiplicative function of the D/A ratio and the DSI. That is, both the overall leverage position of the firm and the relative maturities of assets and liabilities contribute to the combined "intermediate" and "fixed" ratios described by Barry et al.

Application of the DSI to Financial Analysis and Management

The DSI has certain characteristics that make it useful to financial analysts and managers. However, it also has shortcomings that must not be overlooked. Proper interpretation of the index is obviously critical to its usefulness.

An index value of one indicates that the ratio of current to fixed assets is the same as the ratio of current to term liabilities. It also indicates that equity is invested in current and fixed assets in the same proportion as their individual shares of total assets. Values of less than one reveal a larger proportion of fixed assets than term liabilities. That may indicate a future liquidity problem as assets may be generating cash flow or converting to cash at a slower pace than demanded by the maturity structure of liabilities. Conversely, an index value of greater than one may indicate excess future liquidity as assets are (theoretically) converting to cash at a faster pace than demanded by the maturity structure of liabilities. However, in analyzing future liquidity the magnitude of both assets converting to cash and debt repayment requirements is as important as the timing, if not more so.

To illustrate, consider two firms, each with a DSI of 1 and the same volume of assets. Firm A has a D/A ratio of 0.1, while firm B has a D/A ratio of 0.5. With all else equal, Firm B will require five times as much cash to reduce term debt each year as will Firm A. Firm B's likelihood of experiencing liquidity problems is magnified by its financial leverage. Therefore, it is more important to Firm B that it maintain or increase its DSI to properly manage its liquidity. The concept is not new. The topic of restructuring short-term debt into longer-term debt has been widely discussed in recent years. However, it is usually discussed after liquidity problems surface. A step toward proper liquidity planning can be achieved by identifying potential future problems using the DSI in conjunction with the D/A ratio, the level of assets, and earnings criteria such as rates of return.

Another factor in analyzing the DSI is the volume of debt. Again consider two firms, both with a D/A ratio of 0.65 and a DSI of 0.5, indicating that a relatively large amount of short-term debt is being used to finance fixed assets. At first glance both firms would appear to be exposed to the same potential future liquidity problems. However, Firm A has $100,000 in assets and $65,000 in liabilities while Firm B has $1,000,000 in assets and $650,000 in liabilities. The imbalance of the debt and asset maturity structure impacts Firm B more than Firm A, especially if both have similar additional (say, off-farm) income amounts.

Methods of finding the optimal value of most financial ratios are readily apparent from the consistent goals of the owner-manager and the firm's lenders. Differences in risk attitudes or expectations may prevent the optimal values from matching, but the desired direction or magnitude can be regarded as a relatively narrow range. The DSI desired by borrowers and lenders may be substantially more discordant. A firm's desire for flexibility in repayment schedules and low-cost acquisition of a contractual source of liquidity would motivate it to finance short-term assets with longer-term debt. This would indicate a high DSI is in the interest of the firm. However, a firm with a low D/A ratio and a large amount of cash desiring to finance a small portion of a fixed-asset purchase may desire a further decrease in the DSI that would result from borrowing short term. The motivation would emanate from the decreased noninterest borrowing costs of short-term

loans likely to be available to such borrowers.

Lenders' objectives may be in direct conflict. Maintaining borrower communication is thought to be easier with shorter-term loan contracts because of necessary periodic renewal negotiations. In the event of default on the loan contract, collection may be easier if the note is due and payable rather than being delinquent by a payment. Such reasons would motivate lenders to make short-term loans regardless of loan purpose. However, firms demonstrating a lower credit risk may be offered term financing for fixed-asset purchases due to the potential increased profitability of such loans from origination fees and the like. Thus, the proper DSI is not easily targeted.

Furthermore, accurate identification of the proper DSI is hampered by the aggregation of fixed assets and term liabilities of all useful lives and maturities. For example, land purchased with the necessary down payment and financed by a two-year balloon note amortized on a thirty-year basis would not immediately affect the measured DSI any differently than a thirty-year note without a balloon. The potential liquidity problems forthcoming would be revealed by the DSI only on the following year's balance sheet, when the balloon payment converts from a term liability to a current liability. Other such examples abound. Despite the shortcomings of the DSI, measuring the relative maturities of assets and liabilities remains important in managing future liquidity.

Distribution and Correlation with Other Financial Indicators

A sample of 796 farms cooperating in the Illinois Farm Business Farm Management Association (FBFM) had 1986 financial records of sufficient quality to be certified as complete and valid by FBFM field staff. Data from those farms include the following: current, intermediate, long-term, and total assets; current, intermediate, long-term, and total liabilities, accrual net income; accrual interest expense; and gross farm returns. From the data, the D/A ratio, current ratio, return on assets (ROA), return on equity (ROE), return ratio (ROE/ROA) and the DSI were calculated for each farm. Any farm having "zero" current or total liabilities was excluded from further analysis, thereby reducing the sample size to 655.

Table 1 lists descriptive statistics regarding the DSI. The mean of approximately 0.79 indicates that the average farm in the sample had a debt structure that matured more quickly than its assets contributed to cash flow. However, the average D/A ratio of the sample was 0.43, and the average current ratio was 4.2, indicating that present conditions may not forecast a liquidity problem for the average member of the group. The quartile calculations reveal that 25 percent (rounded) of the sample had a DSI greater than one, while nearly another 25 percent of the sample had proportionally twice the concentration in fixed assets as term liabilities.

Table 2 indicates the correlation coefficient between the DSI and various other financial measures. It is not surprising that little correlation is found. The DSI is proposed as an indication of the firm's exposure to future liquidity problems. The other financial indicators presented in Table 2 are measured concurrently with the DSI. The current ratio is the only other commonly used liquidity measure included in the table. The correlation coefficient between the DSI and the current ratio of 0.259 indicates that analyses designed to indicate short-term liquidity may not be sufficiently correlated with longer-term liquidity to use alone. Some correlation between the DSI and both the D/A ratio and long-term liabilities may be expected in this sample

Table 1. Descriptive Statistics of the Debt Structure Index For a Sample of Illinois Farms

Number	655	Minimum	0.01	Upper Quartile	1.00
Mean	0.788	Maximum	6.23	Median	0.81
Std. Dev.	0.441			Lower Quartile	0.55

Table 2. Correlation Coefficient Between Debt Structure Index and Other Financial Characteristics For a Sample of Illinois Farms

Assets	.065	D/A Ratio	.273	Gross Returns	.111
Liabilities	.196	Current Ratio	.259	Interest Exp.	.199
Current Assets	.093	Current Liab.	−.209	Net Income	.045
Intmed. Assets	−.047	Intmed. Liab.	.168	ROE	−.024
Fixed Assets	.076	Long-Term Liab.	.318	ROA	.173
				ROE/ROA	.023

due to the potential for farm land to dominate assets and mortgage debt to dominate liabilities.

Summary and Implications

Common financial ratio analyses do not sufficiently address the timing of liability maturities and rates at which assets are converted to cash or contribute to cash flow. This paper developed a DSI to describe the relative balance between term liabilities and fixed assets. The ratio of term liabilities to fixed assets was shown to be the product of the D/A ratio and the DSI.

A sample of farms from the 1986 Illinois FBFM data set was used to generate statistics on the distribution of the DSI and its correlation with other commonly used financial indicators. It is not surprising that no substantial relationships were discovered because of the concurrent timing of the measures and the differences in their applicabilities to shorter-term or longer-range financial management or analysis. This indicates that appropriate research should be directed toward the ability of the DSI, or other such measures, to forecast liquidity trends three to five years in advance, especially when used in conjunction with existing measures of liquidity, solvency, profitability, and efficiency. As limitations imposed by data quality and quantity are currently disappearing, such results may be available within the next few years. Relationships between the DSI and capital debt repayment capacity, ROA, and ROE, among others, should be investigated to provide meaningful insight into combinations of financial measures for proper liquidity management.

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An Empirical Analysis of Strip and Rollover Interest Rate Hedging

David J. Leatham

Abstract

Interest costs on short-term loanable funds used to finance five-year term assets were simulated from June 1978 to June 1986. Strip hedges were used to protect lenders from rising interest rates the first two years of loan. A rollover hedge was used the last three years. Results show that the spread between the expected yield and hedge yield was very small. Thus, a profit could be locked in if the loan yield was tied to the expected yield on loanable funds. Strip hedges were more effective than rollover hedges, thus, effectiveness of hedges might be increased in shortening loan maturities.

Key words: financial futures, interest rate hedging, fixed rate loans.

Increased interest rate volatility in the 1980s has increased the importance of interest rate risk management by borrowers and lenders. An important component of risk management, from a banker's perspective, is asset-liability management, where the focus is on controlling the difference (gap) between rate-sensitive assets and rate-sensitive liabilities. A rate-sensitive instrument can be defined as an instrument that matures or can be repriced in ninety days or less (Binder). Bankers who obtain funds with short-term liabilities and make fixed-interest-rate term loans must manage a negative gap. Bankers with a negative gap position are vulnerable to changing interest rates because the net interest margins (the difference between interest rate on assets and interest rate on liabilities) narrow as interest rates increase.

Traditionally, the negative gap position has been normal for depository institutions as they have used short-term liabilities to lend in higher yielding term markets. That was a profitable position for most of the 1950s and 1960s given the stable interest rates and upward-sloping yield curve. An increase in interest rate volatility beginning in the late 1970s, however, made the negative gap position much more risky.

The changing and uncertain financial environment requires new strategies for coping with interest rate risk. In principle, an institution can be immunized from interest rate risk by arranging assets and liabilities to create a zero gap position. In practice few commercial banks obtain term liabilities to fund fixed-interest-rate term loans. Many bankers have responded to increased interest rate risk by using adjustable rate loans to create a zero gap. However, shifting interest rate risk back to farmers increased their financial risk and, thus, the likelihood of loan default. Some

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bankers are also exploring ways to shift interest rate risk to a third party by selling fixed-rate notes in secondary markets and by using financial futures and options (Ederington; LaDue and Leatham; McCabe and McLeod; McCabe and Franckle; and Leatham and Baker).

McCabe and McLeod discussed how banks can effectively use financial futures. In particular, they presented a hedging example of how interest futures can be used to manage the interest rate risk associated with a one-year fixed-rate loan financed from a series of four ninety-day certificates of deposit (CDs). Three ninety-day Treasury bill futures contracts (TBFCs) were sold, each with a delivery date that corresponded to the issue date of one of the four CDs. The corresponding TBFC was bought back when each CD was issued. That hedge is frequently referred to as a *strip* hedge.

The length of a strip hedge is limited because delivery dates of financial futures are frequently less than two years. Hedges beyond two years require rolling the hedge forward (rollover hedge); that is, placing the hedge in the most distant available futures contract and rolling the hedge forward as contracts with later delivery dates become available. The rollover continues until the projected issue date of the hedge security matches the delivery date of the futures contract. McCabe and Franckle reported that rollover hedges can be almost as effective as strip hedges.

This study investigates the effectiveness of strip and rollover interest rate hedging as a banker's risk management tool. Although the results of this study can be generalized to all commercial banks, the focus is on commercial banks making fixed-rate agricultural term loans. Assuming that the rate charged on term loans is based on expected cost of loanable funds over the life of the loan, a hedge is used to reduce the difference between actual yield and expected yield on short-term loanable funds. That assumption is different from the work presented by McCabe and Franckle in that here the results stem from actual hedge examples instead of inferring hedge effectiveness from theoretical relationships. Moreover, this study accounts for the time value of money on gains or losses achieved when future contracts are rolled over; that is, the hedging gains or losses received before the hedge contract is issued are compounded forward.

Modeling Approach

The lending situation that is modeled in this study involves a large representative bank that has many agricultural producers in its service area. We assume that the representative bank offers agricultural machinery loans with five-year maturities. Loans are made with a fixed interest rate and prepayment is not allowed. Individual loans are aggregated into a central pool. We assume that the representative bank issues three-month CDs at the Treasury bill (T-bill) rate to obtain the corresponding loanable funds. The interest rate on fixed-interest-rate loans is assumed to be based on the expected cost of corresponding loanable funds at the date the loan pool is finalized. Consequently, the representative bank is vulnerable to unexpected increases in interest rates. However, the representative bank can lock in a predetermined interest margin between the rate on loans and the rate on liabilities, if it can hedge the expected cost of loanable funds.

It is assumed that the bank will use ninety-day TBFCs as the hedging instrument to protect against rising interest rates. The TBFC specifies that at maturity the seller is required to deliver a T-bill with a million dollar face value having thirteen weeks left to maturity. The contract delivery months are March, June, September, and December with eight contracts being traded. T-bills are deliverable on Thursday after the third weekly T-bill auction in delivery months. We assume that all cash and futures market transactions will take place on the first trading day of the month.

Hedge effectiveness is evaluated by comparing the yield on the lender's cost of funds minus expected yield (nonhedge margin) with the hedge yield on the lender's cost of funds minus expected yield (hedge margin). A hedge in this study is considered effective if the absolute value of the hedge margin is smaller than the absolute value of the nonhedge margin. The effectiveness of the hedge increases as the difference

increases. A hedge is considered perfect if the hedge margin is equal to zero. In this study, hedge effectiveness is investigated for hedges that are used to lock in the expected yield on bank liabilities that are issued over the life of the loan ranging from one quarter to nineteen quarters from the issue date of the corresponding loan. Sixteen hedges are simulated through time beginning in 1978 for the selected hedge lengths. The variance of nonhedge margins is compared with the variance of hedge margins to measure the level of risk reduction attributable to strip and rollover hedging. Obviously, a lower variance reflects a more effective hedge.

The hedging examples are simplified in several ways. First, banks cannot issue CDs at the T-bill rate; there would be additional risk from the cross hedge. This is not a problem, however, if the spread between rates on CDs and T-bills is stable. The TBFC is chosen because of its market liquidity. Second, the only cost of hedging considered in this study is the round-turn commission cost. A round turn is the purchase and subsequent sale of a futures contract. We assume that the commission is $78, payable at the end of the round turn. Margins, the bid-asked spread, and term premiums, discussed by McCabe and Franckle, are omitted. For most users, the margin can be posted as a marketable security and is not a significant cost. However, there is a loss in liquidity. Third, futures contracts may not match the maturity dates of funding sources nor the dollar amount of loan requests. Both inequalities reduce the effectiveness of the hedge. Fourth, TBFCs must be traded in million dollar increments. That may make it difficult, particularly for smaller rural banks, to use TBFCs. Combining individual loans into a large loan pool allows a bank to use the TBFCs more effectively. Finally, many banks may not have the resources or personnel to devote to an effective hedging program. However, many banks financing agriculture are becoming a part of branch or other large banking systems and will be able to use this tool (American Bankers Association).

Specification of the Hedging Model

We assume that the representative bank in this study will attempt to lock in the expected yield on CDs that will be issued quarterly to finance a pool of fixed-interest-rate loans with five-year maturities. The first quarter yield is known with certainty because the CDs can be issued concurrent with the loan. We use the yield on the corresponding TBFCs as a proxy for the expected yields on CDs in quarters two through eight.[1] After the eighth quarter, corresponding TBFCs are not available; the expected yield is assumed to be the same as the yield on the TBFC in the eighth quarter.

The yield ($Y_{t,t+1}$) on the lender's cost of funds the first quarter beginning at time t and ending at time $t + 1$ is known with certainty and is calculated as

$$Y_{t,t+1} = [PCD_t(1 + i_t)/P_t] - 1; t = 0, \quad (1)$$

where P_t is the principal the bank must obtain to finance the loan pool, PCD_t is the principal received from the sale of CDs in time t, i_t is the yield on CDs issued in time t, and

$$PCD_0 = P_0. \quad (2)$$

A strip hedge is placed to lock in the bank's expected cost of funds over the next seven quarters. The hedge yield on cost of funds is calculated as

$$Y_{t,t+1} = \{[PCD_t(1 + i_t)]/P_t\} - 1; \quad t = 1, 2, \ldots, 7. \quad (3)$$

Unexpected changes in interest rates will result in a gain or loss from the strip hedge, which will alter the amount of principal

[1]TBFCs are traded in terms of the International Monetary Market (IMM) index. The yield on TBFCs is quoted as an annualized discount rate, d, where

d = 100 − (IMM index on last trading day).

The invoice price, P, of TBFCs is

P = 1 million*(1 − (d/100)/4).

The annual percentage yield, r, on TBFCs is

r = 4{1/[1 − (d/100)/4] − 1}.

For example, a TBFC with a price quote in the *Wall Street Journal* of 85.62 (IMM index) would have an invoice price of $964,050, and it would have an annual percentage yield of 14.9 percent.

from the sale of CDs (PCD_t) that is required to finance the loan pool P_t)

$$PCD_t = P_t - H_t \tag{4}$$

The hedging gain or loss (H_t) is calculated as

$$H_t = N_t[(F_{t,0} - F_{t,t}) - COMS] \tag{5}$$

where N_t is the number of TBFCs that are purchased in time t and is assumed to be one in this study. $COMS$ is the contract commission per round turn. $F_{t,t}$ is the price of the TBFC, where the first subscript represents delivery date of the futures contract and the second subscript represents the time the TBFC is traded. Note that in the strip hedge, futures contracts for $t = 1, 2, \ldots, 7$ are sold at time 0 with a delivery date that corresponds to the date a CD is issued. Each TBFC is bought back simultaneously with the sale of the corresponding CD.

A strip hedge cannot be placed beyond the eighth quarter, therefore, a rollover hedge is used to hedge the bank's cost of funds in the ninth through the twentieth quarters. The hedge yield on cost of funds is calculated as

$$Y_{t,t+1} = \{[PCD_t(1 + i_t)]/P_t\} - 1; \quad t = 8, 9, \ldots, T, \tag{6}$$

where

$$PCD_t = P_t - H_t. \tag{7}$$

The hedging gain or loss (H_t) is calculated as

$$H_t = N_t \sum_{k=7}^{t-1} [(F_{k,k-7} - F_{k,k-6}) - COMS] \prod_{j=k-6}^{t-1} (1 + i_j) + N_t[(F_{t,t-7} - F_{t,t}) - COMS]. \tag{8}$$

The first component of the hedge equation represents the gains and losses associated with rolling the hedge into the next available contract. Those gains and losses are received before the CD is sold; thus, they are compounded foward to account for the time value of money. We assume that hedging gains reduce the amount of CDs that are required to finance the existing loan portfolio. Similarly, we assume that hedging losses are financed by issuing additional CDs. Based on those assumptions, the compound rate used to convert the gains and losses to an equivalent future value is the yield on CDs in each compound period. The rollover hedge is converted to a strip hedge (the second component of the hedge equation) when a contract becomes availiable with a delivery date that corresponds to the date the hedge CD is to be issued.

Decomposition of Hedge Margin

In order to insure a hedge margin of zero (a perfect hedge), the actual yield on the lender's cost of funds, $Y_{t,t+1}$, must equal the expected yield, $E(Y_{t,t+1})$, that is

$$\{[(P_t - H_t^*)(1 + i_t)]/P_t\} - 1 = \{P_t(1 + E(i_t))/P_t\} - 1, \tag{9}$$

where $E(i_t)$ is equal to $E(Y_{t,t+1})$ and H_t^* is the hedging gains or losses required to completely compensate for changes in the lender's cost of funds. Solving for H*

$$H_t^* = [P_t i_t - P_t E(i_t)] / (1 + i_t). \tag{10}$$

The hedge margin, HM_t, can now be written as

$$HM_t = [\{[(P_t - H_t)(1 + i_t)]/P_t\} - 1] - [\{[(P_t - H_t^*)(1 + i_t)]/P_t\} - 1], \tag{11}$$

where the first component is actual yield and the second component is expected yield. The equation can be simplified as a function of the difference between H_t and H_t^*

$$HM_t = -[(1 + i_t)(H_t - H_t^*)]/P_t \tag{12}$$

The difference between H_t and H_t^* can be disaggregated into several factors using the following equations:

$$H_t - H_t^* = FCST_t + FBAS_t + FCRS_t; \quad t = 1, 2, \ldots, 7, \text{ and} \tag{13}$$

$$H_t - H_t^* = FCST_t + FBAS_t + FRGAP_t + FTIME_t + FCRS_t; \quad t = 8, 9, \ldots, T. \tag{14}$$

where *FCST*, *FBAS*, *FCRS*, *FRGAP*, and *FTIME* are the factors that cause H_t to be different from H_t^* due to commission cost, cash basis, cross hedge, rollover price gap, and the interest earned on hedge gains or paid on hedge losses, respectively. Those factors will be discussed in depth later. Moreover, equations (13) and (14) can be substituted into equation (12) to separate the factors that contribute to the nonzero hedge margin:

$$HM_t = -[(1 + i_t)P_t][FCST_t + FBAS_t + FCRS_t]; \quad t = 1, 2, \ldots, 7, \text{ and} \tag{15}$$

$$HM_t = -[(1 + i_t)P_t][FCST_t + FBAS_t + FRGAP_t + FTIME_t + FCRS_t]; \quad t = 8, 9, \ldots, T. \tag{16}$$

An increase in a factor will increase the hedge margin, and a decrease in a factor will increase the hedge margin.

The first factor, *FCST*, is calculated as

$$FCST_t = N_t[-COMS]; t = 1, 2, \ldots, 7, \text{ and,} \tag{17}$$

$$FCST_t = N_t \sum_{k=7}^{t-1} [-COMS] \prod_{j=k-6}^{t-1} (1 + i_j) + N_t[-COMS]; \quad t = 8, 9, \ldots, T. \tag{18}$$

The commission fee results in a decrease in the factor, thus, an increase in the hedge margin. Only one commission charge is incurred when a strip hedge is used. However, an additional commission charge is incurred each time the hedge is rolled over. Consequently, the hedge margin is increased each time the length of the hedge is increased past the eighth quarter (rollover hedge).

The second factor is the cash basis *(FBAS)*, the difference between the cash price and the futures price at any point in time. It is important if the cash basis is nonzero at the time a hedge CD is issued. The factor can be written as

$$FBAS_t = N_t[FCD_{t,t} - F_{t,t}]; \quad t = 1, 2, \ldots, T, \tag{19}$$

where $FCD_{t,t}$ is the price of a TBFC with a yield comparable to the yield on the CD issued at time t. In addition to equations (15) and (16), the change in the hedge margin due to cash basis, $dHMCB_t$, can also be calculated as

$$dHMCB_t = FRT_{t,t} - i_t; \quad t = 1, 2, \ldots, T, \tag{20}$$

where $FRT_{t,t}$ is the yield on a TBFC in its delivery month at time t.

In this study, we assume that all cash and futures market transactions will take place on the first trading day of the month. Because the yields on TBFCs are tied to T-bills that are deliverable after the third weekly T-bill auction in the delivery month, we can expect a nonzero cash basis. In periods where long-term rates are above short-term rates (positive yield curve), the cash yield on T-bills at the date CDs are issued would be lower than the yield on TBFCs to be delivered three weeks later. Thus, the hedge margin would be decreased. Conversely, in periods where long-term rates are below short-term rates (negative yield curve), the cash yield on T-bills at the date CDs are issued would be lower than the yield on TBFCs, thus the hedge margin would be increased.

The third factor, *FRGAP*, is unique to rolling the hedge forward. At the time a hedge is rolled forward to the most distant available contract, a difference between the price of the TBFC sold and the TBFC purchased contributes to the difference between H_t and H_t^*. That difference in prices will be referred to in this study as the rollover price gap, and it is calculated as

$$FRGAP_t = N_t \sum_{k=7}^{t-1} [(F_{k+1,k-6} - F_{k,k-6})] \prod_{j=k-6}^{t-1} (1 + i_j); \quad t = 8, 9, \ldots, T. \tag{21}$$

The factor is negative, thus, the hedge margin is increased if the long-term rates are above short-term rates. Conversely, the hedge margin is decreased if the long-term rates are below short-term rates. The hedge margin will change each time the hedge is rolled over except for the rare situation when the rollover price gap is zero. Only one rollover is required to hedge the CD yield in the ninth quarter. Two rollovers are required in the tenth quarter and so on. The effectiveness of the hedge will likely diminish as the hedge length increases. However, if the slope of the yield curve changes (positive to negative or negative to positive) over the period of time the hedge is being rolled forward, then it is possible for the net absolute rollover price gap to decrease as the hedge length increases.

The fourth factor, *FTIME*, is also unique to rolling the hedge forward. *FTIME* accounts for the time value of money associated with the hedge gains and losses as a hedge is rolled forward. It is a function of the interest earned on hedge gains or of the interest paid on hedge losses net of commission costs and the gains or losses due to rollover price gaps. It is calculated as

$$FTIME_t = N_t \sum_{k=7}^{t-1} [(F_{k,k-7} - F_{k,k-6})] \prod_{j=k-6}^{t-1} (1 + i_j) - N_t \sum_{k=7}^{t-1} [(F_{k,k-7} - F_{k,k-6})]; \quad t = 8, 9, \ldots, T. \tag{22}$$

The first component of the equation is the hedge gains and losses net of commission costs and the gains and losses due to rollover price gaps adjusted for the time value of money. The second component is the hedge gains and losses unadjusted for the time value of money; that is, the second component is the principal amount. Clearly, in periods of rising interest rates, *FTIME* will be positive, reducing the hedge margin. *FTIME* will be negative in periods of declining interest rates. If interest rates fluctuate around the hedge rate during the time period future contracts are rolled over, it is not clear whether the net *FTIME* will be positive or negative.

The final factor, $FCRS_t$, represents the difference in H_t and H_t^* due to the cross hedge used in this study. We assume that the rate on CDs will be the same as the rate on T-bills, so the rate difference is not a factor. However, the price of a T-bill will change less than the price of a CD with the same principal amount in response to a change in interest rates. The cause of this difference is simply that the price of a T-bill is the principal amount discounted to the present and the price of a CD is the principal plus interest discounted to the present. Given the same principal amount, the CD is more sensitive to changes in interest rates. The hedge margin will increase if interest rates rise above the hedge rate, and it will decrease if interest rates drop below the hedge rate. The effect of net cross hedge on the difference between H_t and H_t^* can be determined by solving equation (14) for $FCRS_t$:

$$FCRS_t = H_t - H_t^* + FCST_t - FBAS_t - FRGAP_t - FTIME_t, \quad t = 8, 9, \ldots, T, \tag{23}$$

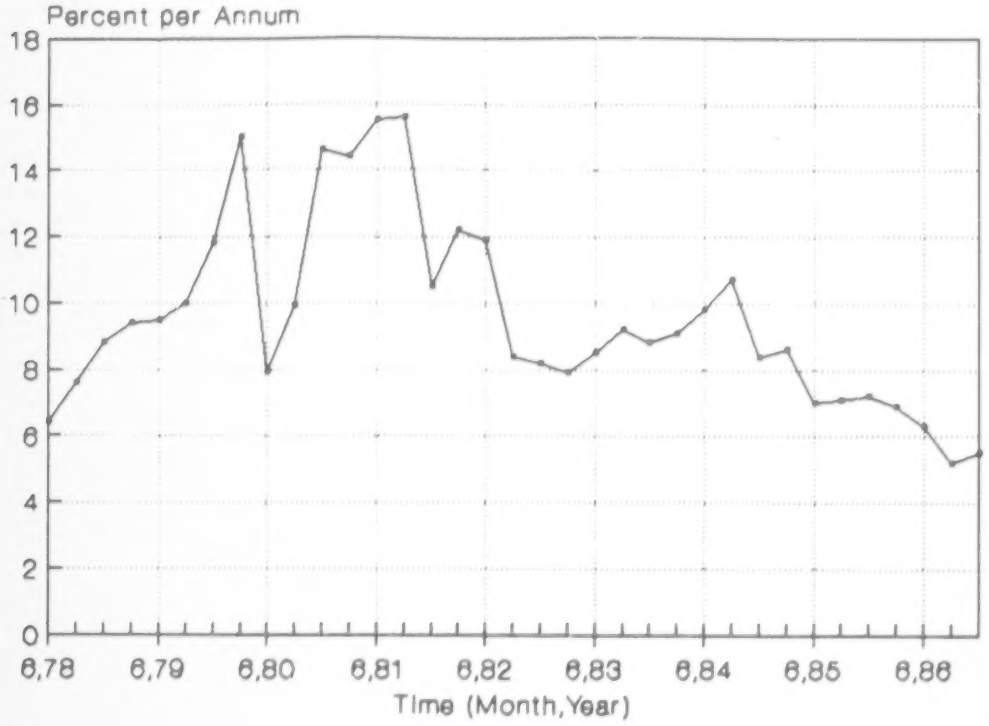
because the other variables have been specified earlier.

Results

The historical effectiveness of strip and rollover hedges was tested by simulating the quarterly cost of a representative bank's loanable funds used to finance a pool of fixed-rate loans. We assumed that the loan principal was constant at one million dollars over a five-year period. Strip and rollover hedges were placed to hedge the expected yield on CDs issued quarterly by the representative bank. Sixteen five-year loan periods were simulated. The first five-year loan period began in June 1978. A new loan period was started quarterly. Historical data ranged from June 1978 to June 1986.

Interest rates were volatile and rising from June 1978 to September 1981 (Figure 1). In late 1981, interest rates fell sharply. Since late 1983, interest rates have been less

Figure 1. Historical T-Bill Rates



volatile and have trended downward. We first show the results of the hedge that began in June 1978 as an example of hedge effectiveness during a period of rising and volatile interest rates. Second, we show the results of the hedge beginning in March 1982 as an example of hedge effectiveness during a period of declining and less volatile interest rates. Finally, hedging results from the sixteen loan periods are summarized.

Loan Period Beginning June 1978

Results from the simulation beginning June 1978 are reported in Table 1 and Figure 2. Actual yields on T-bills over the five-year period were volatile and usually much higher than expected. The actual yield was 656 basis points higher than expected in the fourteenth quarter. Only in the ninth, eighteenth, nineteenth, and twentieth quarters were the actual yields lower than expected.

Absolute difference between the hedge yield and the expected yield was small. That was especially true for the second through the eighth quarters when a strip hedge was used. The hedge margin ranged from a low of −30 basis points in the third quarter to a high of 18 basis points in the seventh quarter. This could be compared with the nonhedge margin that ranged from a low of 14 basis points in the second quarter to a high of 593 basis points in the eighth quarter.

Only three factors contributed to the nonzero hedge margin when strip hedge was used in quarters two through eight (Table 2). The commission cost contributed 3 basis points each quarter. Cash basis was positive in all quarters except for the seventh quarter, thus reducing the hedge margin. The cash basis contributed a high of 8 basis points in the seventh quarter and a low of −35 basis points in the third quarter. The cross hedge contributed little to the hedge margin. Interest rates were higher than expected during that period of time, and the effect of the cross hedge on

Table 1. A Summary of Strip and Rollover Hedges That Began June 1978[a]

Month/ Year (1)	Time t (2)	Expected Cash T-Bill Yield per Annum (3)	Actual Cash T-Bill Yield per Annum (4)	Hedge T-Bill Yield per Annum $Y_{t,t+1}$ (5)	Hedge Margin (6) = (5) − (3)	Hedge Gains or Losses H_t (7)
	Quarters					
6/78	0	6.43%[b]	6.43%	6.43%	0.00%	$ 0.
9/78	1	7.46[b]	7.60	7.38	−0.08	547.
12/78	2	7.88[b]	8.80	7.59	−0.30	2972.
3/79	3	8.20[b]	9.42	8.10	−0.10	3222.
6/79	4	8.47[b]	9.51	8.37	−0.09	2772.
9/79	5	8.71[b]	10.03	8.54	−0.16	3622.
12/79	6	8.90[b]	11.84	9.08	0.18	6697.
3/80	7	9.12[b]	15.05	9.20	0.08	14097.
6/80	8	9.12[c]	7.90	9.40	0.27	−3670.
9/80	9	9.12[c]	9.90	9.02	−0.11	2159.
12/80	10	9.12[c]	14.65	9.27	0.14	12982.
3/81	11	9.12[c]	14.48	9.17	0.04	12821.
6/81	12	9.12[c]	15.50	9.60	0.48	14197.
9/81	13	9.12[c]	15.68	9.49	0.37	14895.
12/81	14	9.12[c]	10.50	8.11	−1.01	5825.
3/82	15	9.12[c]	12.24	9.29	0.17	7144.
6/82	16	9.12[c]	11.98	9.14	0.01	6898.
9/82	17	9.12[c]	8.41	8.15	−0.98	643.
12/82	18	9.12[c]	8.26	8.80	−0.32	−1332.
3/83	19	9.12[c]	7.96	8.79	−0.33	−2040.

[a]The interest rates on T-bills and the price of T-bill futures contracts were obtained from the *International Monetary Market Yearbook*.

[b]The implied yield on the corresponding T-bill futures contract.

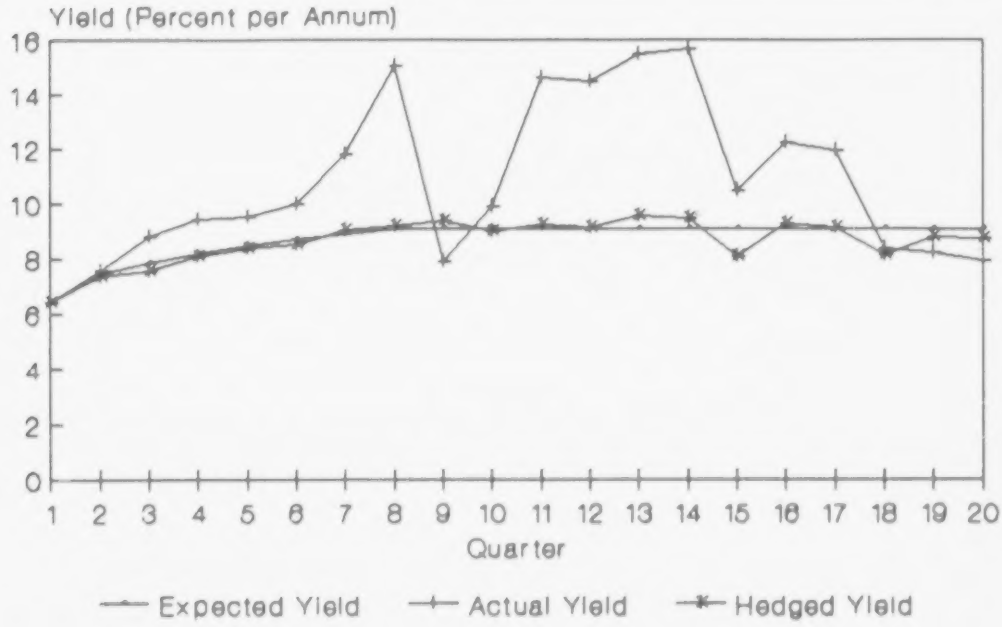
[c]Assumed to be the same as the implied yield on the most distant available T-bill futures contract.

the hedge margin was positive. The cross hedge contributed a low of 2 basis points and a high of 13 basis points to the hedge margin.

The absolute hedge margin was also small in quarters nine through twenty when a rollover hedge was used (Table 1). The absolute hedge margin did not exceed 50 basis points until the fifteenth quarter. The hedge margin ranged from a low of −101 basis points in the fifteenth quarter to a high of 48 basis points in the thirteenth quarter. The nonhedge margin, on the other hand, ranged from a low of −122 basis points in the ninth quarter to a high of 656 basis points in the fourteenth quarter.

Five factors contributed to a nonzero hedge margin when the rollover hedge was used (Table 2). The commission cost increased as length of the hedge increased; thus, its contribution to the hedge margin also increased. The commission cost contributed 59 basis points in the twentieth quarter. The cash basis was positive in all quarters, and it reduced the hedge margin as much as 80 basis points in the eighteenth quarter. The net rollover price gap was positive, and it increased the hedge margin by as much as 68 basis points in the seventeenth quarter. Over most of that period of time actual rates were higher than expected, and there were hedge gains when the TBFCs were rolled forward. The interest earned on those gains resulted in a decrease in the hedge margin. An exception was noted in quarters nine, ten, twelve, and thirteen. When the TBFCs were rolled forward, interest rates were below expected rates in at least some of the years, and there was a net hedge loss. Interest paid on those losses resulted in an increase in the hedge margin. The final contributor to the hedge margin was a cross hedge. The effect of the cross hedge on the hedge margin was insignificant. The most it contributed to the hedge margin was 15 basis points in the fourteenth quarter. As expected, its contribution was positive in those quarters when the actual

Figure 2. Expected, Actual, and Hedge T-Bill Yields Over Five Years Beginning June 1978



rate was higher than expected and negative when the actual rates were lower than expected.

Ex post we concluded that strip and rollover hedges would have been effective. Over the twenty quarters, the bank would have been protected from rising interest rates, and the average hedge margin would have been −8.7 basis points. The negative hedge margin favors the lender because cost of funds would have been lower than expected. In addition, the banker's borrowers would have been protected from the higher-than-expected interest rates, thus reducing the likelihood of loan default. However, ex ante, the lender does not know which way interest rates will move. In the next example the hedge was placed during a period of time when interest rates moved below the expected rates.

Loan Period Beginning March 1982

Results from the simulation beginning in March 1982 are reported in Table 3 and Figure 3. Actual T-bill yields were lower than the expected yield over the entire five years. They dropped sharply in the second quarter before trending upward for the next nine quarters. In the tenth quarter, interest rates dropped again and trended downward for the rest of the period.

There was only a minor difference between hedge yield and expected yield for the first ten quarters (Table 4). Short-term rates were lower than long-term rates over the period resulting in a positive cash basis, thus, reducing the hedge margin. Concurrent with the sharp decline in interest rates in the third period, a large positive cash basis resulted in an 80 basis point hedge margin reduction. Because the actual rate was below the expected rate, the cross hedge also reduced the hedge margin. Effects of the cash basis and cross hedge overshadowed effects of the commission cost during the first ten quarters, and the hedge margin was always negative.

The hedge margin was positive after the tenth quarter rising as high as 208 basis points in the twentieth quarter (Table 3). The commission cost, rollover price gap, and interest paid on rollover hedge losses contributed to the positive hedge margin in

Table 2. Decomposition of Hedge Margins From Hedges That Began June 1978

		Components of the Hedge Margin					
Month/ Year (1)	Time t (2)	Commission Cost (3)	Cash Basis (4)	Rollover Price Gap (5)	Time Value of Rollover Hedge Gains or Losses (6)	Cross Hedge (7)	Hedge Margin (8) = (3) + (4) + (5) + (6) + (7)
	Quarters	*Basis Points*					
9/78	1	3	−11	0	0	0	−8
12/78	2	3	−35	0	0	2	−30
3/79	3	3	−16	0	0	2	−10
6/79	4	3	−14	0	0	2	−9
9/79	5	3	−22	0	0	3	−16
12/79	6	3	8	0	0	6	18
3/80	7	3	−9	0	0	13	8
6/80	8	7	−2	21	4	−3	27
9/80	9	11	−49	24	1	2	−11
12/80	10	16	−26	25	−13	12	14
3/81	11	20	−56	22	5	12	4
6/81	12	25	−15	7	17	14	48
9/81	13	30	−13	9	−5	15	37
12/81	14	34	−52	7	−93	3	−101
3/82	15	40	−55	52	−26	7	17
6/82	16	45	−33	68	−85	6	1
9/82	17	49	−80	57	−122	−2	−98
12/82	18	54	−11	62	−135	−2	−32
3/83	19	59	−9	63	−144	−3	−33

each quarter. The cross hedge was the only factor that consistently reduced the hedge margin. Even the cash basis fluctuated from positive to negative, thus, its effect on the hedge margin also fluctuated.

Ex post we concluded that a lender would have been better off without the hedge. The hedge margin was as high as 208 basis points in the twentieth quarter and averaged 50 basis points over the twenty quarters (Table 3). The positive hedge margin would be a disadvantage to the lender because the cost of funds would have been higher than expected. In addition, the actual rate averaged 486 basis points below the expected rate. The nonhedge margin was as low as −805 basis points in the nineteenth quarter. If the lender had made adjustable rate loans, the lower rates on loanable funds could have been passed to borrowers. On the other hand, if the lender had made five-year fixed-rate loans without hedging, the lender would have received the expected fixed rate on loans but would have paid the lower-than-expected rate on loanable funds. The borrower, of course, would have been better off with an adjustable rate loan in this period of lower-than-expected interest rates. Despite the fact that ex post both the borrower and the lender were better off without the hedge, the hedge was effective given that the hedge margin was much closer to zero than the nonhedge margin.

Results indicate that both the hedge initiated on June 1978 (Table 1) and the hedge initiated on March 1983 (Table 3) were effective for at least eight quarters; that is, the absolute hedge margin was close to zero. The absolute hedge margin was, in general, higher and more erratic when the hedges were rolled forward. During the periods when actual rates were above expected rates, interest on hedge gains from hedge rollovers overcompensated for increased commission costs and the rollover price gap (Table 2). The hedge margins in each quarter remained close to zero and were usually negative. During the periods of time when actual rates were below expected rates, the interest paid on hedge losses from hedge rollovers combined with increased commission costs and rollover price gaps to increase the hedge margin (Table 4). In general, the hedge margin increased as the length of hedge increased.

It is apparent from the two previous

Table 3. A Summary of Strip and Rollover Hedges That Began March 1982[a]

Month/ Year (1)	Time t (2)	Expected Cash T-Bill Yield per Annum (3)	Actual Cash T-Bill Yield per Annum (4)	Hedge T-Bill Yield per Annum $Y_{t,t+1}(5)$	Hedge Martin (6) = (5) − (3)	Hedge Gains or Losses H_t (7)
	Quarters					
6/78	0	12.24%[b]	12.24%	12.24%	0.00%	$ 0.
9/78	1	12.97[b]	11.98	12.64	−0.33	−1603.
12/78	2	13.20[b]	8.41	12.28	−0.92	−9478.
3/79	3	13.24[b]	8.26	13.01	−0.24	−11628.
6/79	4	13.30[b]	7.96	13.07	−0.23	−12528.
9/79	5	13.33[b]	8.54	13.02	−0.30	−10978.
12/79	6	13.33[b]	9.25	13.01	−0.32	−9178.
3/80	7	13.33[b]	8.84	12.94	−0.39	−10028.
6/80	8	13.33[c]	9.15	13.03	−0.30	−9475.
9/80	9	13.33[c]	9.82	13.32	−0.01	−8548.
12/80	10	13.33[c]	10.70	14.04	0.71	−8127.
3/81	11	13.33[c]	8.40	14.36	1.03	−14588.
6/81	12	13.33[c]	8.65	14.51	1.18	−14351.
9/81	13	13.33[c]	7.03	14.72	1.39	−18904.
12/81	14	13.33[c]	7.12	15.14	1.81	−19708.
3/82	15	13.33[c]	7.26	14.46	1.13	−17679.
6/82	16	13.33[c]	6.97	14.17	0.84	−17701.
9/82	17	13.33[c]	6.34	14.38	1.05	−19777.
12/82	18	13.33[c]	5.28	15.17	1.84	−24393.
3/83	19	13.33[c]	5.51	15.41	2.08	−24415.

[a]The interest rates on T-bills and the price of T-bill futures contracts were obtained from the *International Monetary Market Yearbook*.

[b]The implied yield on the corresponding T-bill futures contract.

[c]Assumed to be the same as the implied yield on the most distant available T-bill futures contract.

Figure 3. Expected, Actual, and Hedge T-Bill Yields Over Five Years Beginning March 1982

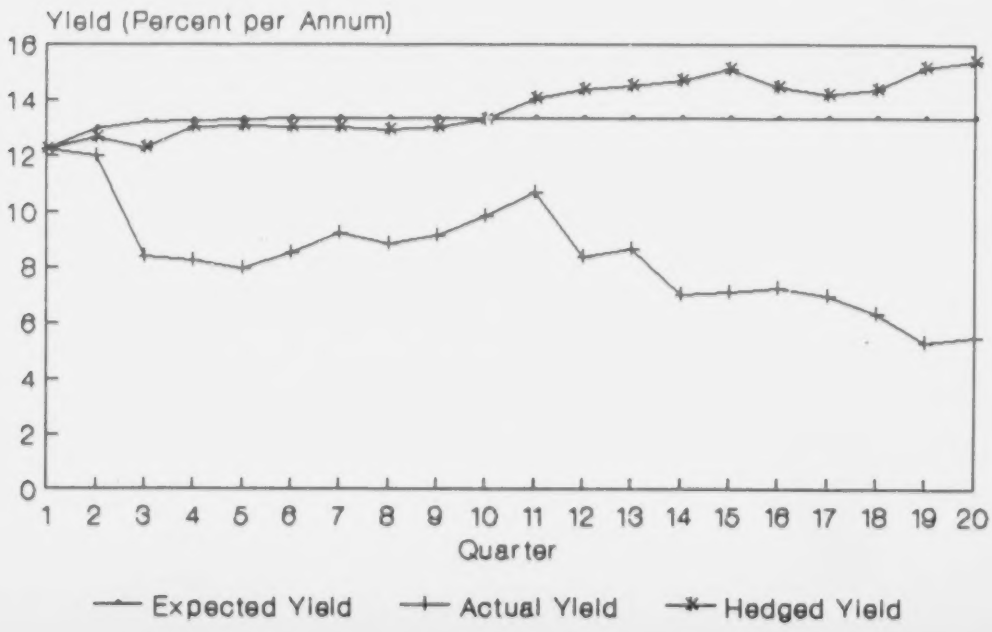


Table 4. Decomposition of Hedge Margins From Hedge That Began March 1982

Month/ Year (1)	Time (t) (2)	Components of the Hedge Margin: Commission Cost (3)	Cash Basis (4)	Rollover Price Gap (5)	Time Value of Rollover Hedge Gains or Losses (6)	Cross Hedge (7)	Hedge Margin (8) = (3) + (4) + (5) + (6) + (7)
	Quarters	*Basis Points*					
6/82	1	3	−33	0	0	−3	−33
9/82	2	3	−80	0	0	−15	−92
12/82	3	3	−11	0	0	−16	−24
3/83	4	3	−9	0	0	−17	−23
6/83	5	3	−18	0	0	−15	−30
9/83	6	3	−22	0	0	−13	−32
12/83	7	3	−28	0	0	−14	−39
3/84	8	7	−27	1	2	−13	−30
6/84	9	11	−19	1	17	−11	−1
9/84	10	15	0	11	53	−8	71
12/84	11	19	−23	38	84	−16	103
3/85	12	23	−23	60	73	−15	118
6/85	13	27	−5	75	63	−20	139
9/85	14	31	−5	100	75	−20	181
12/85	15	36	3	3	91	−20	113
3/86	16	40	−1	21	45	−21	84
6/86	17	44	−15	36	62	−23	105
9/86	18	48	12	66	83	−26	184
12/86	19	52	10	87	85	−25	208

examples that strip and rollover hedges were effective in reducing interest rate risk. However, the effectiveness of the rollover hedge beyond eight quarters decreased as the length of the hedge increased. Moreover, the effectiveness was time and situation specific.

Summary of Hedges in Sixteen Five-Year Loan Periods

Fourteen additional five-year loan periods were simulated beginning in September 1978. A new loan and hedging situation was initiated quarterly. Descriptive statistics were obtained on the hedge margin and nonhedge margin from the sixteen observations for each hedge length (Table 5).

Over the time period modeled, the absolute average hedge margin did not exceed 30 basis points (Table 5). The average hedge margin was negative until the hedge length exceeded fourteen quarters. The average cash basis over the study period was positive, and it was the principal factor contributing to a negative hedge margin (Table 6). The average commission cost increased each time a hedge was rolled forward, thus, the average hedge margin also increased as the length of the hedge increased. The commission cost was the principal factor contributing to the positive hedge margin after the hedge length exceeded fourteen quarters. Long-term rates were higher than short-term rates on the average when hedges were rolled forward; therefore, the rollover price gap factor increased the average hedge margin. Actual rates were higher than expected rates on the average when hedges were rolled forward; consequently, money was received from gains on TBFCs when they were rolled forward. Interest received on hedge gains overcompensated for hedge losses attributable to the rollover price gap. Effects of the cross hedge on the average hedge margin was minimal.

Over the time period modeled, the absolute average, the standard deviation, and the minimum and maximum margins of the hedge were less than the comparable statistics for the nonhedge margin. From this we can conclude that strip and rollover hedges were successful at reducing interest rate risk. The minimum hedge margin was −158 basis points, and the maximum hedge margin was 208 basis points (Table 5). The standard deviation of the hedge margin was

Table 5. Comparison of Descriptive Statistics Between Hedge and Nonhedge Margins of Quarterly T-Bill Yields per Annum

Hedge Length in Quarters[a]	Mean		Standard Deviation		Percent Reduction in the Variance e	Minimum		Maximum	
	Hedge Margin	Nonhedge Margin	Hedge Margin	Nonhedge Margin		Hedge Margin	Nonhedge Margin	Hedge Margin	Nonhedge Margin
	Basis Points					*Basis Points*			
1	−21.	38.	22.	277.	99.4%	−67.	−662.	16.	440.
2	−25.	64.	30.	315.	99.1	−92.	−479.	18.	631.
3	−24.	70.	27.	319.	99.3	−86.	−498.	16.	627.
4	−24.	63.	30.	377.	99.4	−96.	−570.	17.	678.
5	−24.	57.	28.	414.	99.5	−90.	−580.	18.	677.
6	−25.	49.	27.	426.	99.6	−90.	−612.	18.	630.
7	−28.	26.	26.	458.	99.7	−90.	−554.	8.	699.
8	−29.	−11.	52.	434.	98.6	−133.	−483.	77.	717.
9	−30.	1.	58.	424.	98.1	−161.	−524.	73.	681.
10	−25.	6.	50.	428.	98.6	−153.	−493.	71.	641.
11	−21.	−33.	66.	410.	97.4	−130.	−493.	103.	659.
12	−15.	−70.	86.	374.	94.7	−158.	−468.	118.	676.
13	−11.	−123.	94.	339.	92.4	−155.	−630.	146.	656.
14	−4.	−176.	108.	282.	85.3	−138.	−621.	181.	332.
15	6.	−196.	112.	296.	85.6	−142.	−705.	187.	312.
16	7.	−229.	117.	287.	83.4	−142.	−696.	231.	286.
17	9.	−265.	115.	277.	82.8	−145.	−699.	180.	117.
18	21.	−284.	123.	297.	82.9	−151.	−805.	186.	64.
19	30.	−301.	129.	331.	84.8	−142.	−782.	208.	137.

[a]Hedges were placed quarterly starting in June 1978, and the last hedges placed were in March 1982. Thus, there are sixteen observations. A hedge length of nineteen implies that the hedge is lifted nineteen quarters after it is placed. Historical data ranged June 1978–June 1986.

around 28 basis points when hedge lengths were less than seven quarters (strip hedge). Standard deviation increased from 52 basis points to 129 basis points as the hedge length increased from eight quarters to nineteen quarters. The minimum nonhedge margin was −805 basis points, and the maximum nonhedge margin was 717 basis points. Standard deviation of the nonhedge margin ranged from 277 basis points to 458 basis points depending on length of the hedge. Surprisingly, standard deviation of the nonhedge margin was lower when the time period exceeded thirteen quarters. Also, the nonhedge margin averaged 22 basis points when the nonhedge length was one quarter, and it decreased gradually to an average of −301 basis points when the nonhedge length was nineteen quarters. The explanation is that more of the sixteen observations for the shorter nonhedge lengths occurred during the first part of the study period. As noted previously, rates were volatile and higher than expected (Table 1). Thus, the average and the variation of the nonhedge margins were higher. Similarly, more of the sixteen observations for longer nonhedge lengths occurred during the latter part of the study period where average interest rates were less volatile and lower than expected.

In addition to evaluating the effectiveness of strip and rollover hedges by observing how close the hedge margin was to zero, it was useful to calculate the percent reduction of interest rate risk obtained by hedging. The percent reduction of the nonhedge margin variance, e, was calculated as

$$e = 1 - [\mathrm{VAR}(Y_h)/\mathrm{VAR}(Y_u)], \tag{24}$$

where $\mathrm{VAR}(Y_h)$ denoted the variance on the hedge margin and $\mathrm{VAR}(Y_u)$ denoted the variance on the nonhedge margin (Ederington). The nonhedge margin variance was reduced more than 99 percent when a strip hedge was used (Table 5). If the hedge length exceeded seven quarters (rollover hedge), the effectiveness of the hedge declined progressively. The nonhedge margin variance was reduced more than 90

Table 6. Decomposition of Average Hedge Margin for Sixteen Hedges Placed Quarterly Starting in June 1978

	Components of the Hedge Margin					
Hedge Length in Quarters (1)	Commission Cost (3)	Cash Basis (4)	Rollover Price Gap (5)	Time Value of Rollover Hedge Gains or Losses (6)	Cross Hedge (7)	Hedge Margin (8) = (3) + (4) + (5) + (6) + (7)
	Basis Points					
1	3.	−25.	0.	0.	0.	−21
2	3.	−29.	0.	0.	1.	−25
3	3.	−28.	0.	0.	1.	−24
4	3.	−27.	0.	0.	1.	−24
5	3.	−28.	0.	0.	0.	−24
6	3.	−28.	0.	0.	0.	−25
7	3.	−30.	0.	0.	−1.	−28
8	7.	−31.	4.	−7.	−2.	−29
9	11.	−32.	7.	−15.	−2.	−30
10	16.	−29.	10.	−21.	−1.	−25
11	20.	−29.	15.	−24.	−2.	−21
12	24.	−27.	22.	−31.	−3.	−15
13	29.	−26	30.	−39.	−4.	−11
14	33.	−26.	41.	−46.	−6.	−4
15	38.	−22.	45.	−48.	−6.	6.
16	42.	−19.	48.	−58.	−7.	7.
17	47.	−18.	51.	−63.	−8.	9.
18	52.	−12.	56.	−66.	−9.	21.
19	56.	−11.	63.	−69.	−9.	30.

percent in hedge lengths of up to thirteen quarters. A reduction in variance of 84.8 percent was achieved with (five-year) hedges.

Concluding Comments

Commercial banks' decision to offer fixed-rate loans is important in view of volatile interest rates and the pervasiveness of financial stress in agriculture. Fixed rates protect farmers from increases in interest rates on existing loans, thus, decreasing financial risk and likelihood of loan default. Banks, however, must also protect themselves from adverse changes in interest rates. Short-term liabilities as a source of loanable funds used to finance term assets must be rolled over periodically at new rates. The ability of banks to match fixed-rate term assets with fixed-rate term liabilities may be limited. Thus, there is a need for bankers to consider interest rate hedging alternatives.

In this study, we show that, under the conditions modeled, banks can effectively hedge short-term liabilities using interest rate futures. The interest costs on short-term loanable funds used to finance five-year term assets were simulated from June 1978 to June 1986. Strip hedges were used to protect the bank from rising interest rates the first two years. A rollover hedge was used the last three years. Results show that the spread between the hedge and expected yield on loanable funds was very small. If the asset yield was tied to the expected yield on loanable funds, a profit spread could have been locked in.

The results show that strip and rollover hedging can be effective over a five-year period. However, the hedge is most effective for the first two years (strip hedge). The spread between hedge and expected yield on loanable funds diverged the last three years as the number of hedge rollovers increased. Effectiveness of the hedge could be increased by shortening loan maturity. However, the likelihood of loan default would increase, and the trade-off would have to be addressed.

In practice, a bank may not be able to eliminate all the interest rate risk associated

with fixed-rate loans. Strip and rollover hedges are not perfect. However, significant risk reduction can be achieved with the hedging approach outlined in this paper and should be seriously considered.

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Capital Gains, Optimal Leverage, and the Probability of Equity Loss: A Theoretical Model

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Abstract

The Tax Reform Act of 1986 eliminated capital gains deductions. Because of the importance of capital gains to investment in agriculture, that change could have considerable ramifications for investment decisions. This study constructs a theoretical model explaining the effect of the elimination of the capital gains deduction on investment decisions and tests the model using aggregate U.S. agricultural data. The results indicate that the elimination of the capital gains exclusion raises optimal leverage levels and the probability of a negative rate of return to equity for all levels of risk aversion.

Key words: capital gains, optimal debt choice, risk balancing.

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Dramatic changes in the U.S. federal income tax system have occurred in the 1980s. In 1981, Congress passed the Economic Recovery Tax Act (ERTA), which significantly reduced the marginal tax rates and increased the rate at which capital assets could be expensed through depreciation. In 1982, Congress reversed some of the tax advantages given in ERTA in an attempt to reduce the growing budget deficit. By 1986, the emphasis in Congress shifted to tax simplification primarily through the elimination of deductions. Under the tax simplification program, tax brackets were again reduced and the capital gains exclusion eliminated.

The implications of federal income tax policy is well documented in agricultural economics literature. Davenport et al. provided a fairly exhaustive list of the effects of tax policy on domestic agriculture. Recently, Hanson and Bertelson explained the implications of the most recent changes. Typically the literature emphasizes three research focuses. Pederson and Lynne each depict one of those. Pederson examined the implications of tax policy on the leasing decision. Lynne updated work by Chisholm that examined the effect of the tax code on the machinery replacement decision. The second major focus is epitomized by Nixon and Richardson. They examined the effect of tax policy on the whole farm firm using simulation. Finally Hardesty et al. used a deterministic dynamic optimization model to analyze the effect of changes in tax code on farm investment decisions.

This study constructs a theoretical investment model to determine the effect of eliminating the capital gains exclusion on optimal leverage and the probability of

equity loss. Specifically, the study uses an extension of Collins's model to deduce the change in optimal leverage position due to the elimination of the 60 percent capital gains exclusion. Then, given the optimal leverage position, the change in the probability of equity loss due to the elimination of the capital gains exclusion is computed. Thus, this study is similar in focus to Hardesty et al. However, the effort de-emphasizes dynamics and integrates risk into the decision process. Further, unlike Nixon and Richardson, this study is concerned with the optimizing behavior of the firm.

Extending Collins's Model

Collins developed a simple investment model to show how making returns more certain could increase the probability of bankruptcy by increasing the optimal leverage position for farmers. The model assumes that producers maximize expected utility of wealth by choosing a leverage position. Specifically, Collins defines the rate of return to equity as R_E

$$R_E = \left[\frac{r_p}{A} + i - K\delta\right]\frac{1}{(1-\delta)}, \qquad (1)$$

where r_p is the return to a portfolio of agricultural enterprises, A is the value of agricultural assets, i is the rate of capital appreciation,[1] K is the cost of capital, and δ is the leverage ratio (debt to assets).

Income tax considerations have been added to Collins's model changing equation (1) to

$$R_E = \left[\frac{r_p(1-\tau)}{A} + (1-\psi\tau)i - K(1-\tau)\delta\right]\frac{1}{(1-\delta)}, \qquad (2)$$

where R_E is now the after-tax rate of return to equity, τ is the marginal tax, and ψ is the fraction of the capital gain taxed as ordinary income. The after-tax return to assets is $r_p(1-\tau)$. The after-tax capital gains rate becomes $(1-\psi\tau)i$. In the pre-1987 tax code, only 40 percent of capital gains were taxed at ordinary rates (that is, $\psi = .4$).

Defining R_A as the rate of return to assets and rewriting equation (2), yields

$$R_E = [R_A - K(1-\tau)\delta]\frac{1}{1-\delta}, \text{ where}$$

$$R_A = \frac{r_p(1-\tau)}{A} + (1-\psi\tau)i. \qquad (3)$$

The return to equity, R_E is a function of the return to assets R_A. The variance of returns to equity is a function of the variance of returns to assets and the leverage ratio given a deterministic cost of capital and marginal tax rate. Specifically, the variance of the rate of return to equity becomes

$$\sigma_E^2 = \sigma_A^2\frac{1}{(1-\delta)^2}, \text{ where} \qquad (4)$$

$$\sigma_A^2 = (1-\tau)^2\left[\frac{\sigma_p^2}{A^2} + \frac{(1-\psi\tau)^2}{(1-\tau)^2}\sigma_i^2 + \frac{2}{A}\frac{(1-\psi\tau)}{(1-\tau)}\sigma_{ip}\right],$$

and σ_p^2 is the variance of the operating returns to assets, σ_i^2 is the variance of capital gains, and σ_{ip} is the covariance of capital gains and returns to assets. Likewise, the expected rate of return on equity is

$$\bar{R}_E = [\bar{R}_A - K(1-\tau)\delta]\frac{1}{(1-\delta)}, \text{ where}$$

$$\bar{R}_A = \frac{\bar{r}_p}{A}(1-\tau) + (1-\psi\tau)\bar{i}, \qquad (5)$$

$\bar{r}_p$ is the average return to the portfolio of agricultural assets, and $\bar{i}$ is the average capital gain.

To derive the optimal leverage position in Collins's model, one assumes that utility

[1]The definition of capital gains in this study is important. Capital gains in agriculture typically arise from land, but they may also result from livestock held for breeding. Because the depreciable portion of the livestock investment is fairly small in most cases, and there is no depreciation on land, the confounding between changes in depreciation and elimination of capital gains is anticipated to be small. Machinery and structures more directly affected by depreciation are not typically affected by capital gains provisions because of section 1245 and section 1250 recapture provisions.

is negative exponential. Following Freund[2], the investor maximizes utility by maximizing the certainty equivalent $V[\delta]$ where ρ is the absolute Arrow-Pratt risk aversion coefficient and $\bar{R}_A$ and σ_A^2 are the after-tax mean and variance, respectively, of the rate of return to assets.

$$\max V[\delta] = [\bar{R}_A - K(1 - \tau)\delta] \frac{1}{(1 - \delta)} - \frac{\rho}{2} \sigma_A^2 \frac{1}{(1 - \delta)^2}. \quad (6)$$

The first-order condition for maximizing expected utility of the rate of return to equity as a function of leverage is

$$\frac{\partial V[\delta]}{\partial \delta} = -\frac{K(1 - \tau)}{(1 - \delta)} + \frac{[\bar{R}_A - K(1 - \tau)\delta]}{(1 - \delta)^2} - \frac{\rho\sigma_A^2}{(1 - \delta)^3} = 0. \quad (7)$$

Solving equation (7) for the optimal leverage yields

$$\delta^* = 1 - \frac{\rho\sigma_A^2}{[\bar{R}_A - K(1 - \tau)]} \quad (8)$$

This expression indicates that the optimal leverage position is a decreasing function of the variance of the rate of return on assets, a decreasing function of the cost of capital, and an increasing function of the expected return on assets, all of which are consistent with Collins's results. The optimal leverage position is also a decreasing function of the level of risk aversion and the marginal tax rate.

The next section extends Collins's results to examine the effect of changes in the capital gains exclusion on optimal leverage position by examining the effect of changes in the capital gains exclusion on the expected rate of return to assets and the variance of the rate of returns to assets.

Capital Gains and Optimal Leverage

The effect of the capital gains exclusion on optimal leverage can be derived from equation (8). Totally differentiating equation (8) with respect to σ_A^2, $\bar{R}_A$, τ, and K yields

$$d\delta^* = -\frac{\rho}{[\bar{R}_A - K(1 - \tau)]} d\sigma_A^2 + \frac{\rho\sigma_A^2}{[\bar{R}_A - K(1 - \tau)]^2} d\bar{R}_A + K\frac{\rho\sigma_A^2}{[\bar{R}_A - K(1 - \tau)]^2} d\tau - \frac{\rho\sigma_A^2(1 - \tau)}{[\bar{R}_A - K(1 - \tau)]^2} dK. \quad (9)$$

The effect of the elimination of capital gains exclusion on optimal leverage position can then be derived from

$$\frac{d\tau^*}{d\psi}\Big|_{\substack{d\tau=0 \\ dK=0}} = -\frac{\rho}{[\bar{R}_A - K(1 - \tau)]} \frac{d\sigma_A^2}{d\psi} + \frac{\rho\sigma_A^2}{[\bar{R}_A - K(1 - \tau)]^2} \frac{d\bar{R}_A}{d\psi} \gtreqless 0. \quad (10)$$

Setting $d\tau = dK = 0$ focuses attention on the effects of the capital gains exclusion on optimal leverage position via changes in the expected rate of return on assets and the variance of the rate of return on assets.

Taking the derivative of $\bar{R}_A$ in equation (5) with respect to ψ yields the change in expected rate of return to assets with a change in the capital gains exclusion or

$$\frac{\partial \bar{R}_A}{\partial \psi} = -\tau\bar{i} < 0. \quad (11)$$

[2]Specifically, Freund's assumptions are that preferences are negative exponential and asset returns are normally distributed. The remainder of this study continues under the assumption of normality for computational purposes. However, recent literature suggests that decisions from mean variance models may be consistent with a broader class of expected utility maximization assumptions (Meyer).

While the change in the variance of rate of returns to assets from equation (4) becomes

$$\frac{\partial \sigma_A^2}{\partial \psi} = -2\tau(1-\tau)\left[\frac{(1-\psi\tau)}{(1-\tau)}\sigma_i^2 + \frac{\sigma_{ip}}{A}\right] < 0. \tag{12}$$

Thus, both the expected rate of return to assets and the variance of the rate of return to assets decrease as ψ increases (the capital gains exclusion vanishes as the proportion of the gain taxed as ordinary income, ψ, increases).

This indicates that change in the optimal leverage position becomes a function of the relation between the variance and the expected return of capital gains and the variance and the expected return of operating income. Specifically, substituting equation (11) and (12) into equation (10) it can be shown that the sign of $d\delta^*/d\psi$ depends on

$$2[\bar{R}_A - K(1-\tau)]\left[(1-\tau\psi)\sigma_i^2 + \frac{\sigma_{ip}(1-\tau)}{A}\right] - \sigma_A^2 \bar{i} \gtreqless 0. \tag{13}$$

If equation (13) is greater than zero then $d\delta^*/d\psi > 0$, or optimal leverage increases as the capital gains exclusion vanishes. A more intuitive explanation is that the capital gains exclusion is related to the amount of investor's risk that is assumed by the government. Taxation decreases the before-tax gain or loss from an investment. If an investment returned $100, then a marginal tax rate of 20 percent would reduce the gain to the investor to $80. An increase in the tax rate (in this case by eliminating capital gains treatment) reduces the risk of an investment by reducing the variance of the investment's returns. Hence, the net effect of eliminating the capital gains deduction on optimal leverage position is a function of the portion of risk and returns arising from capital gains versus the risk and returns from operating income.

The effect of the elimination of the capital gains exclusion on optimal leverage position, the rate of return to assets, and the variance of returns to assets implies changes in the mean and variance of the rate of return to equity. Taking the derivative of equations (4) and (5)

$$\frac{d\bar{R}_E}{d\psi} = [\bar{R}_A - K(1-\tau)]\frac{1}{(1-\delta^*)^2}\frac{d\delta^*}{d\psi} + \frac{1}{(1-\delta^*)}\frac{d\bar{R}_A}{d\psi} \gtreqless 0, \tag{14}$$

and

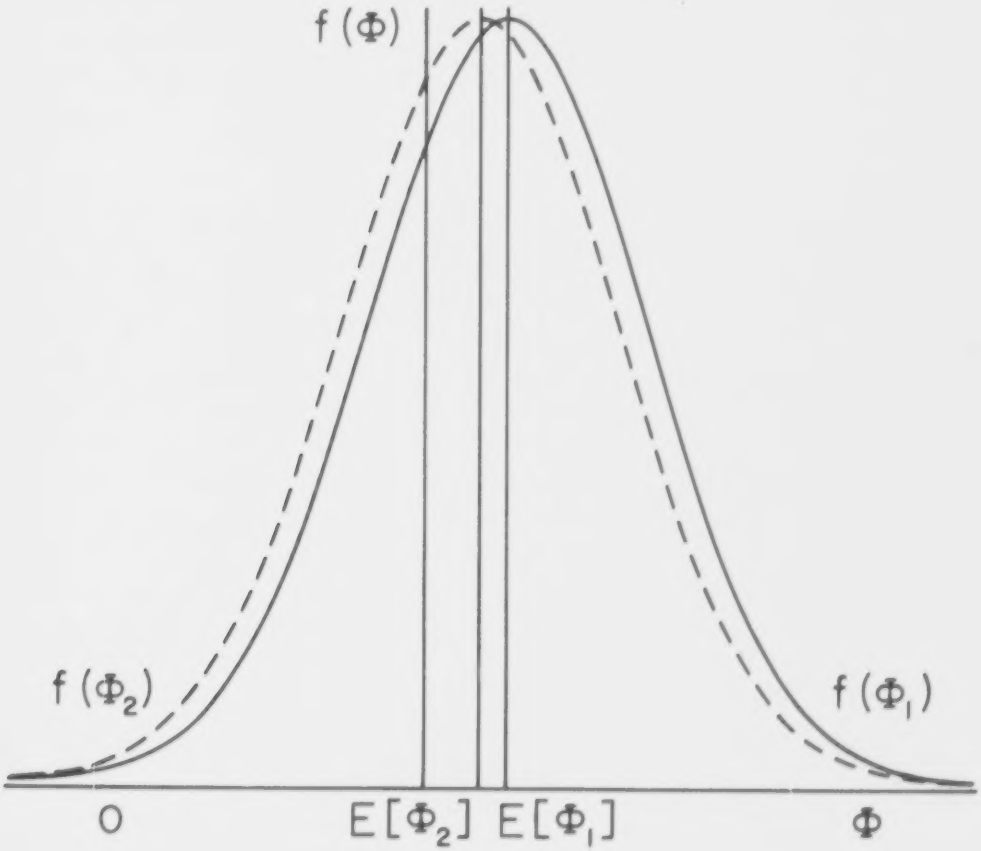
$$\frac{d\sigma_E^2}{d\psi} = \frac{1}{(1-\delta^*)^2}\frac{d\sigma_A^2}{d\psi} + \frac{2\sigma_A^2}{(1-\delta^*)^3}\frac{d\delta^*}{d\psi} \gtreqless 0. \tag{15}$$

These conditions assume optimal responses by investors. The change in the expected rate of return to equity and the variance of the rate of return to equity are functions of the optimal leverage position.

There are three possible outcomes for equations (10), (14), and (15). First, the optimal leverage position could decline ($d\delta^*/d\psi < 0$). In that case, the expected rate of return to equity will decline along with the variance of the rate of return to equity. Second, the optimal leverage position could increase causing the variance of the rate of return to equity to increase. However, the increased leverage is insufficient to cause an increase in the expected rate of return to equity. Finally, the increase in optimal leverage position could be large enough to cause an increase in the expected rate of return to equity as well as in the variance of the rate of return to equity.

Given a normal distribution of the rate of return to equity with mean $\bar{R}_E$ and variance σ_E^2, the probability of a negative return to equity is directly related to the coefficient of variation. The coefficient of variation, given that the mean of the distribution is greater than zero, is the distance of the mean away from zero in standard deviations. It is also in a random variable distributed $\Phi \sim N(\bar{R}_E/\sigma_E, 1)$. As $\bar{R}_E/\sigma_E$ changes, the distribution of Φ shifts in a parallel fashion as in Figure 1. If $E[\Phi_1] > E[\Phi_2]$ then $P[R_E < 0 \mid \Phi_1] < P[R_E < 0 \mid \Phi_2]$, which is also evident from the graph. Hence, the change in the probability of a

Figure 1. Change in Probability Distribution Rate of Return to Equity Divided by the Standard Deviation of the Rate of Return to Equity



negative rate of return to equity is directly related to $dE[\Phi]$. The actual change in the probability of a negative return to equity could be derived by differentiating the integral of the probability density function for Φ from $-\infty$ to 0. Unfortunately, the closed form integral of the normal distribution function does not exist. However, the change in probability can be computed numerically.

The numerator of the random variable Φ is the standard deviation, but the properties of the variance are more easily defined. By squaring Φ, the resulting random variable is easy to analyze based on previous results for variance, especially equation (15). Further, the transformation is monotonic order preserving if $E[\Phi] > 0$. Differentiating $E[\Phi^2]$ with respect to ψ yields

$$\frac{dE[\Phi]^2}{d\psi} = \frac{2\bar{R}_E}{\sigma_E^2}\frac{d\bar{R}_E}{d\psi} - \frac{\bar{R}_E^2}{(\sigma_E^2)^2}\frac{d\sigma_E^2}{d\psi} \gtreqless 0. \tag{16}$$

If $dE[\Phi^2]/d\psi$ is equal to or greater than zero, the probability of an equity loss declines with an increase in the tax rate on capital gains.

Equation (16) suggests dividing the effect of the elimination of the capital gains exclusion into an average effect and a variance-related portion. Intuitively, one would expect that the effect of eliminating the capital gains treatment would be to increase the probability of a negative rate of return on equity ($d\bar{R}_E/d\psi < 0$). However, eliminating the capital gains exclusion also

affects the variability of the rate of return to equity. The second effect depends on the amount of risk assumed by the government through increasing the tax rate on capital gains. Specifically, the elimination of preferential treatment of capital gains reduces the relative riskiness of capital gains. Eliminating a portion of the risk of holding productive assets results in increased leverage. If the increase in leverage is sufficiently large, the reduction in the business risk is dominated by the increase in financial risk. This leads to a net increase in risk as postulated in Gabriel and Baker. Prior studies have indicated that the increase in financial risk does more than offset the decline in business risk (Featherstone et al.).

Because of the complexity of equations (10), (14), and (15), an unambiguous result from equation (16) is not possible. Therefore, in the next section aggregate data are used to produce the change in the probability of equity loss due to the elimination of capital gains exclusion under various risk aversion coefficients.

Empirical Results

Because the analytical direction of change is indeterminant, additional information about the rate of return to agriculture is required to demonstrate the effect of the elimination of the capital gains exclusion on agriculture. To provide that information, this study focuses on a representative producer. Assuming that the distribution of the return to agriculture would serve as a proxy for the distribution for the representative producer, this study uses the rate of return data for the sector as a whole.

The data in Melichar indicated that the average return to agricultural assets before interest payments and capital gains was $23.06 between 1950 and 1986 with a variance of 1.057. The average level of real assets was $726.5 during the period; the average real appreciation rate for assets computed as the log change in real asset values was 0.005471 with a variance of 0.003650. The covariance between capital gains and operating returns was 216.28. Thus the average return to assets assuming a 20 percent tax rate and a 60 percent capital gains exclusion was 0.030420 with a variance of 0.003655. The real cost of capital was assumed to be 3 percent.[3]

Table 1 indicates that the elimination of the capital gains exclusion results in increased leverage for all levels of risk aversion. The aggregate debt-to-asset ratio in 1986 was 22.86 percent (Melichar), therefore the effect of the elimination of capital gains with $\rho = 1.4$ may provide an approximation of the effect of eliminating the capital gains deduction on the farm sector as a whole because the original leverage position at this level of risk aversion is close to the observed aggregate leverage position. At $\rho = 1.4$ the optimal leverage measure increased by 0.1067. Further, the percentage change in optimal leverage is directly related to the risk aversion coefficient. Thus, more risk averse individuals will have the largest increases in optimal leverage.

Table 1 also indicates that eliminating capital gains increases the probability of equity loss for all levels of risk aversion. The Φ^2 declines at every level of risk aversion, but the decrease in Φ^2 is larger for the most risk averse solutions. The larger change in Φ^2 for higher risk aversion levels implies that the most risk averse investors suffer the greatest increase in the probability of equity loss. That fact is born out by the actual change in probabilities. At $\rho = 1.4$, the probability of equity loss increased from 26.29 percent to 31.31 percent. Thus, one effect of eliminating the capital gains exclusion is that the range of probability of equity loss narrows.

Those aggregate results suggest that eliminating the capital gains exclusion will result in increased optimal leverage levels and in an increased probability of negative returns to equity at all levels of risk aversion.

Conclusions

This study derived a simplified optimal investment model to examine the effect of

[3]Our results are robust to a reduction in the real interest rate. A real interest rate of 2 percent causes increased leverage at all levels and a general increase in the probability of equity loss. Increasing the real cost of debt to 4 percent was not possible because the cost of debt would then exceed the rate of return to agriculture.

Table 1. Change in Optimal Leverage and Probability of Equity Loss Resulting from Elimination of Capital Gains Treatment

Risk Aversion Coefficient	Original Optimal Leverage	Change in Optimal Leverage	Change in Φ^2 Ratio	Original Probability of Equity Loss	New Probability of Equity Loss	Change in Probability of Equity Loss
0.0100	.9943	.0008	−.0002	.4606	.4611	.0005
0.1000	.9431	.0076	−.0011	.4256	.4267	.0011
0.5000	.7153	.0381	−.0220	.3501	.3612	.0111
0.7500	.5729	.0572	−.0488	.3200	.3400	.0201
0.8000	.5445	.0610	−.0554	.3147	.3367	.0221
0.9000	.4875	.0686	−.0699	.3046	.3309	.0263
0.9500	.4591	.0724	−.0778	.2999	.3283	.0285
0.9750	.4448	.0743	−.0819	.2976	.3271	.0296
1.0000	.4306	.0762	−.0861	.2953	.3260	.0307
1.0750	.3879	.0819	−.0993	.2886	.3229	.0342
1.1250	.3594	.0857	−.1086	.2844	.3210	.0366
1.2500	.2882	.0953	−.1338	.2742	.3172	.0429
1.3000	.2598	.0991	−.1446	.2704	.3159	.0456
1.4000	.2028	.1067	−.1675	.2629	.3139	.0510
1.5000	.1459	.1143	−.1921	.2556	.3126	.0568
1.6000	.0889	.1219	−.2183	.2490	.3119	.0628
1.7500	.0035	.1334	−.2608	.2395	.3119	.0725
1.7562	.0000	.1338	−.2627	.2391	.3119	.0729

changes in the tax code on agriculture. Specifically, the effect of eliminating the capital gains exclusion on leverage and the distribution of the rate of return to equity was examined using aggregate data. The results indicate that the elimination of the capital gains exclusion results in an increased optimal leverage level with reduced rate of returns to equity and increased variance of the rate of return to equity. Furthermore, the data suggest that the elimination of capital gains treatment causes an increase in the probability of equity loss in agriculture.

This study assumed that debt adjustment can occur instantaneously and that the variance of the rate of return to assets is fixed. Divergence of the theoretical results from observed trends in optimal leverage may then be explained by two factors. First, the adjustment of leverage positions may be sluggish. Thus, the decline in aggregate leverage since 1986 may be attributable to financial stress in the early 1980s. Second, the variance of returns to assets may vary over time. Therefore recent decreases in leverage may be attributed to increased risk (Shonkwiler et al.).

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